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Gildea

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(54) **METHOD AND COMMUNICATION SYSTEM FOR LIMITING THE FUNCTIONALITY OF AN ELECTRONIC DEVICE**

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(22) Filed: **Jun. 17, 2008**

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G01S 19/52 (2010.01)
G01S 11/10 (2010.01)

(52) **U.S. Cl.** **342/357.35**; 342/357.78

(58) **Field of Classification Search** 342/357.35, 342/357.78, 461; 455/441; 340/466, 670; *G01S 11/10, 13/64, 19/52*

See application file for complete search history.

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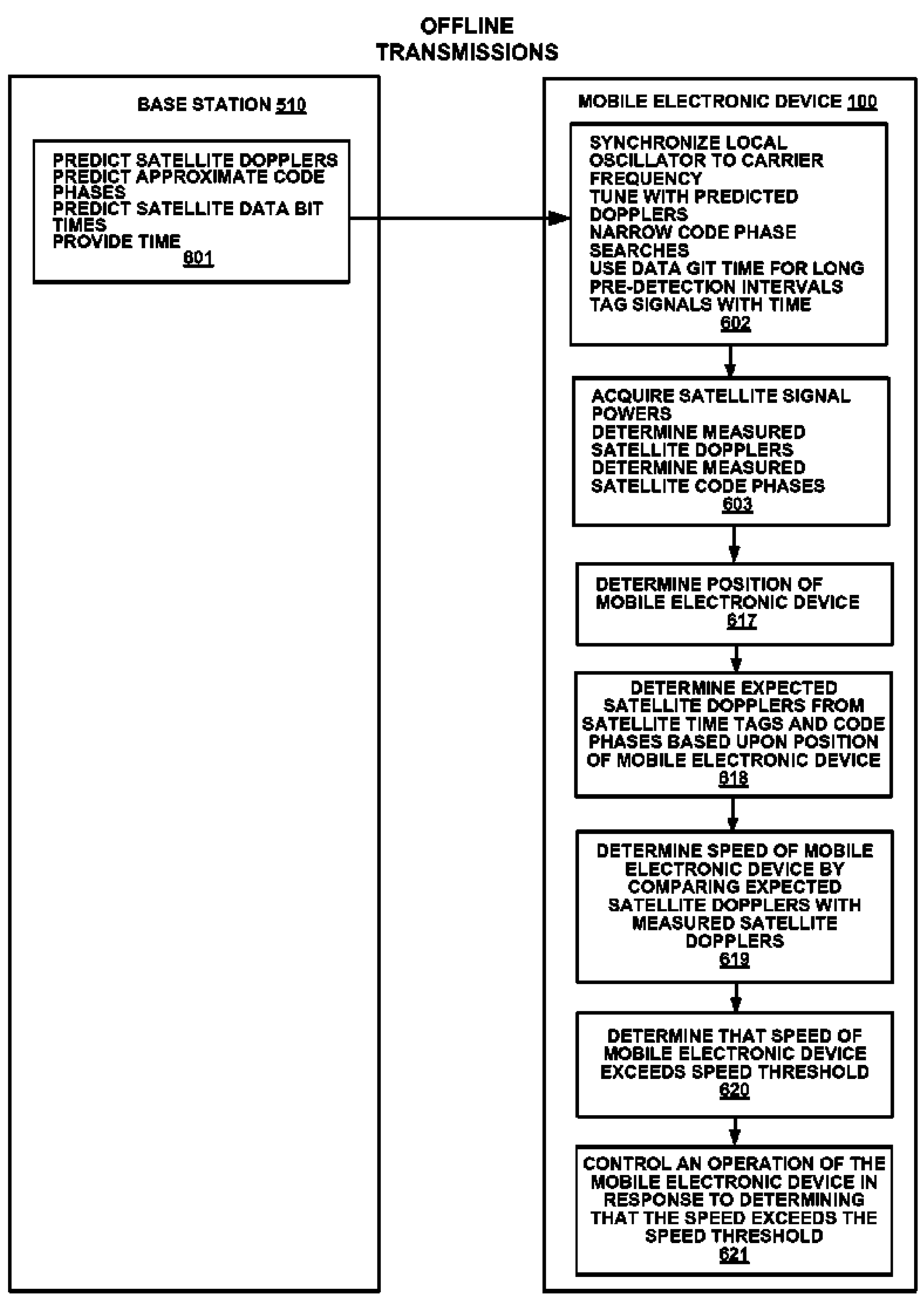
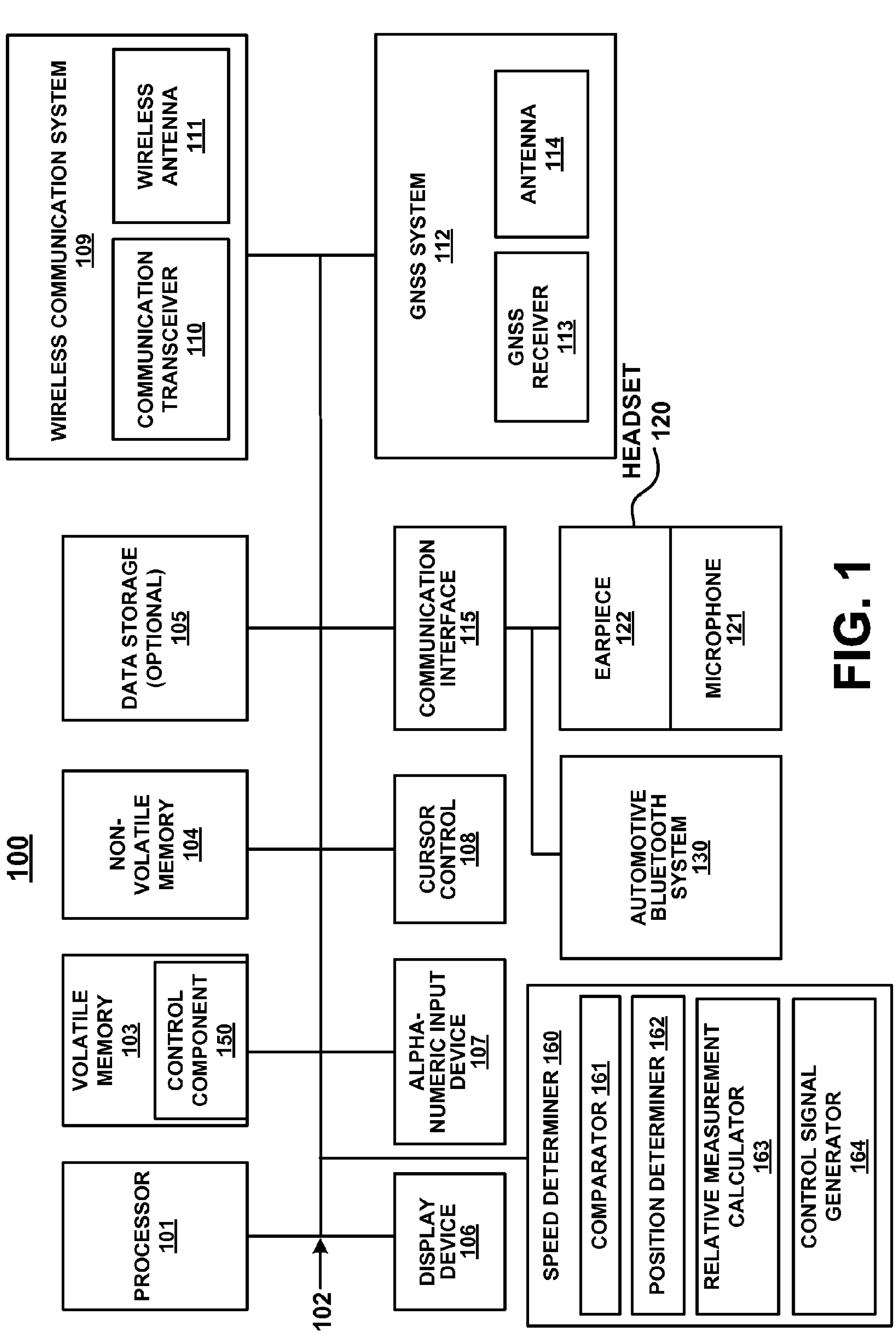
(57) **ABSTRACT**

Embodiments of the present invention recite a method and system for limiting the functionality of a mobile electronic device. In one embodiment, a Global Navigation Satellite System (GNSS) receiver configured to determine a GNSS Doppler frequency shift measurement corresponding to a GNSS signal. A control component is configured to control an operation of the mobile electronic device in response to a control signal which is generated when the GNSS Doppler frequency shift measurement is used to determine that the speed of the mobile electronic device exceeds a speed threshold.

32 Claims, 13 Drawing Sheets

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WIRELESS COMMUNICATION SYSTEM 109
COMMUNICATION TRANSCEIVER 110
WIRELESS ANTENNA 111
GNSS SYSTEM 112
GNSS RECEIVER 113
ANTENNA 114
HEADSET 120
DATA STORAGE (OPTIONAL) 105
COMMUNICATION INTERFACE 115
EARPIECE 122
MICROPHONE 121
NON-VOLATILE MEMORY 104
CURSOR CONTROL 108
AUTOMOTIVE BLUETOOTH SYSTEM 130
VOLATILE MEMORY 103
CONTROL COMPONENT 150
ALPHA-NUMERIC INPUT DEVICE 107
SPEED DETERMINER 160
COMPARATOR 161
POSITION DETERMINER 162
RELATIVE MEASUREMENT CALCULATOR 163
CONTROL SIGNAL GENERATOR 164
PROCESSOR 101
DISPLAY DEVICE 106
102

FIG. 1

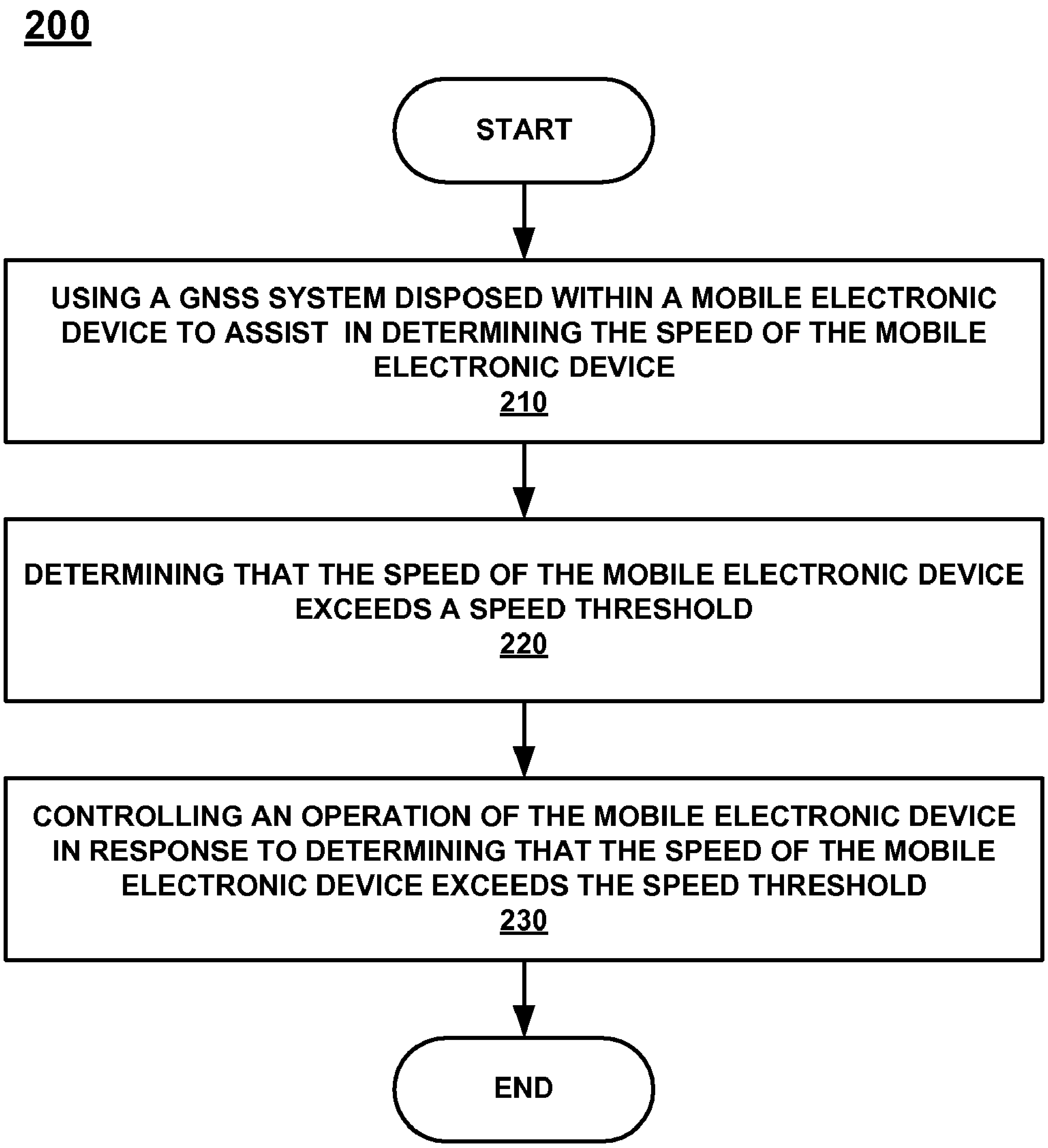

200
START
USING A GNSS SYSTEM DISPOSED WITHIN A MOBILE ELECTRONIC DEVICE TO ASSIST IN DETERMINING THE SPEED OF THE MOBILE ELECTRONIC DEVICE
210
DETERMINING THAT THE SPEED OF THE MOBILE ELECTRONIC DEVICE EXCEEDS A SPEED THRESHOLD
220
CONTROLLING AN OPERATION OF THE MOBILE ELECTRONIC DEVICE IN RESPONSE TO DETERMINING THAT THE SPEED OF THE MOBILE ELECTRONIC DEVICE EXCEEDS THE SPEED THRESHOLD
230
END

FIG. 2

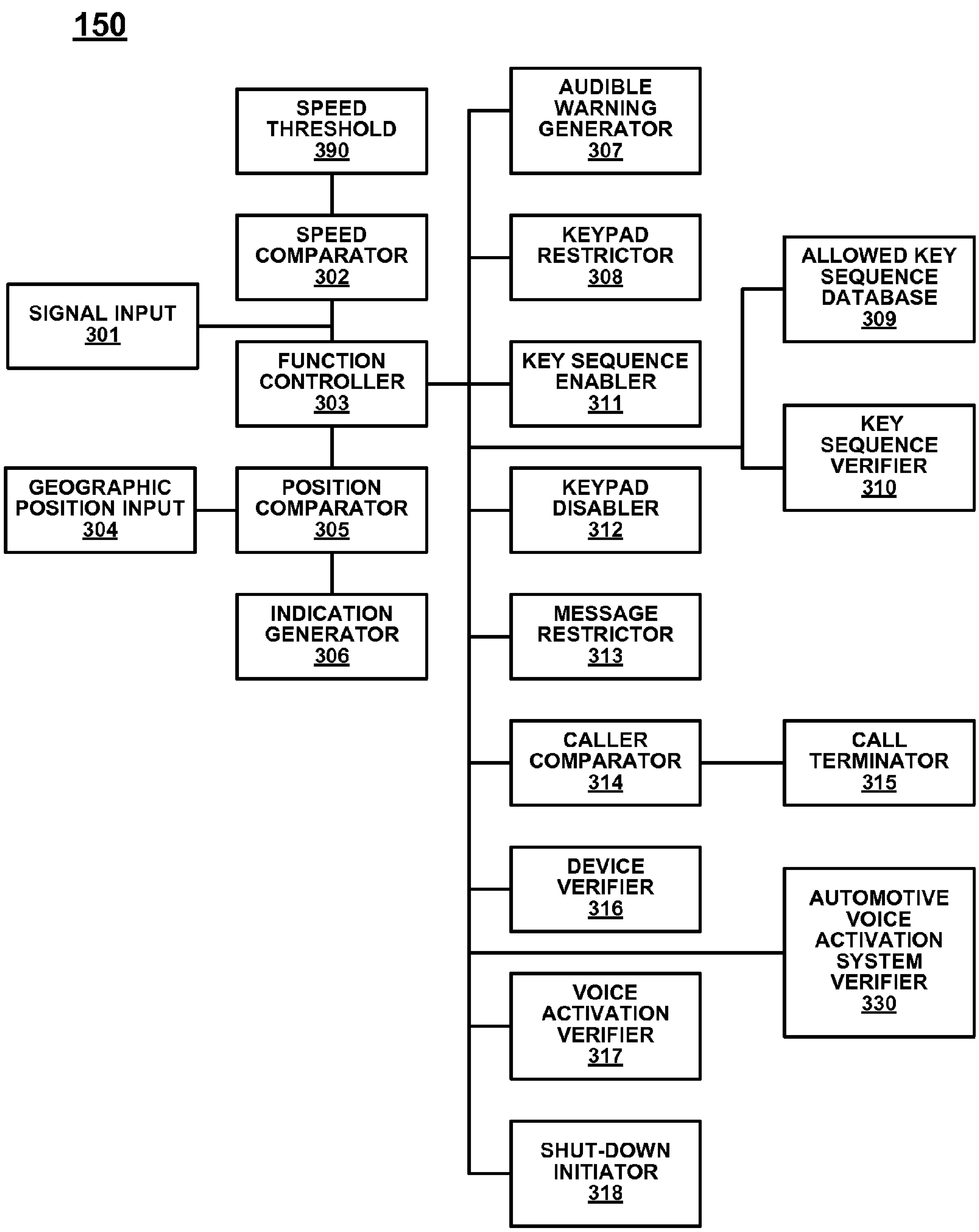

150
SPEED THRESHOLD 390
SPEED COMPARATOR 302
SIGNAL INPUT 301
FUNCTION CONTROLLER 303
GEOGRAPHIC POSITION INPUT 304
POSITION COMPARATOR 305
INDICATION GENERATOR 306
AUDIBLE WARNING GENERATOR 307
KEYPAD RESTRICTOR 308
ALLOWED KEY SEQUENCE DATABASE 309
KEY SEQUENCE ENABLER 311
KEY SEQUENCE VERIFIER 310
KEYPAD DISABLER 312
MESSAGE RESTRICTOR 313
CALLER COMPARATOR 314
CALL TERMINATOR 315
DEVICE VERIFIER 316
AUTOMOTIVE VOICE ACTIVATION SYSTEM VERIFIER 330
VOICE ACTIVATION VERIFIER 317
SHUT-DOWN INITIATOR 318

FIG. 3

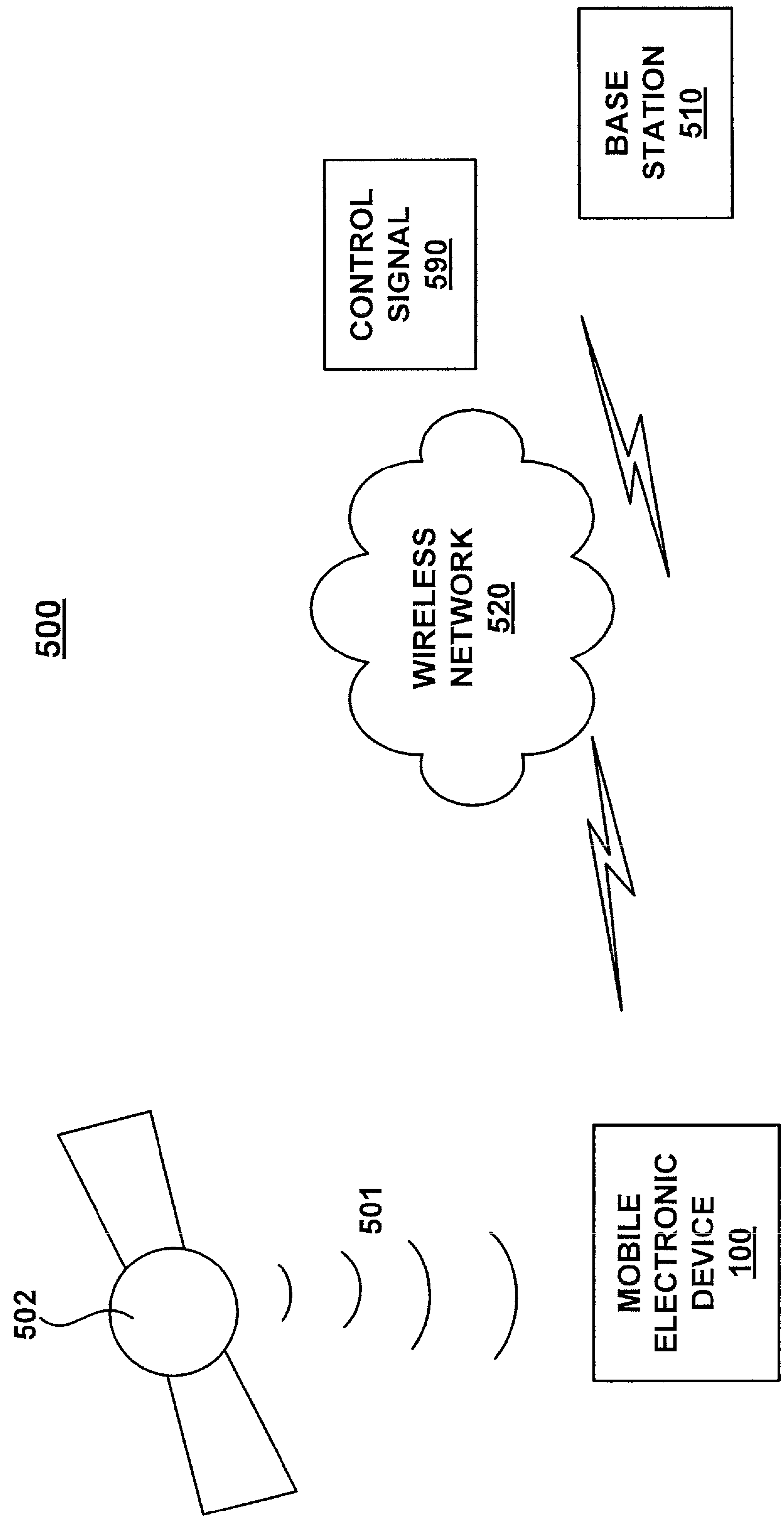

500
CONTROL SIGNAL 590
BASE STATION 510
WIRELESS NETWORK 520
502
501
MOBILE ELECTRONIC DEVICE 100

FIG. 4

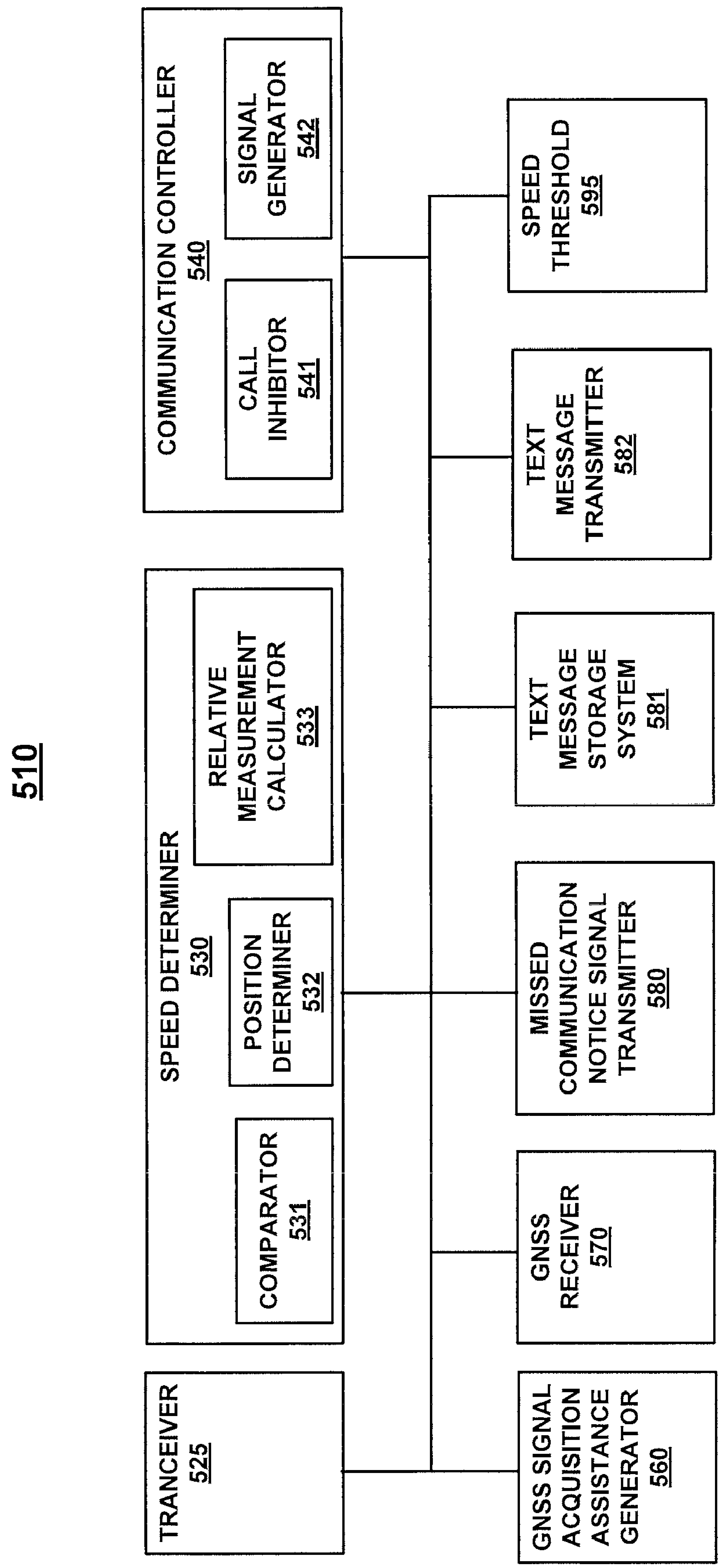

510
COMMUNICATION CONTROLLER 540
SIGNAL GENERATOR 542
CALL INHIBITOR 541
SPEED DETERMINER 530
RELATIVE MEASUREMENT CALCULATOR 533
POSITION DETERMINER 532
COMPARATOR 531
TRANCEIVER 525
SPEED THRESHOLD 595
TEXT MESSAGE TRANSMITTER 582
TEXT MESSAGE STORAGE SYSTEM 581
MISSED COMMUNICATION NOTICE SIGNAL TRANSMITTER 580
GNSS RECEIVER 570
GNSS SIGNAL ACQUISITION ASSISTANCE GENERATOR 560

FIG. 5

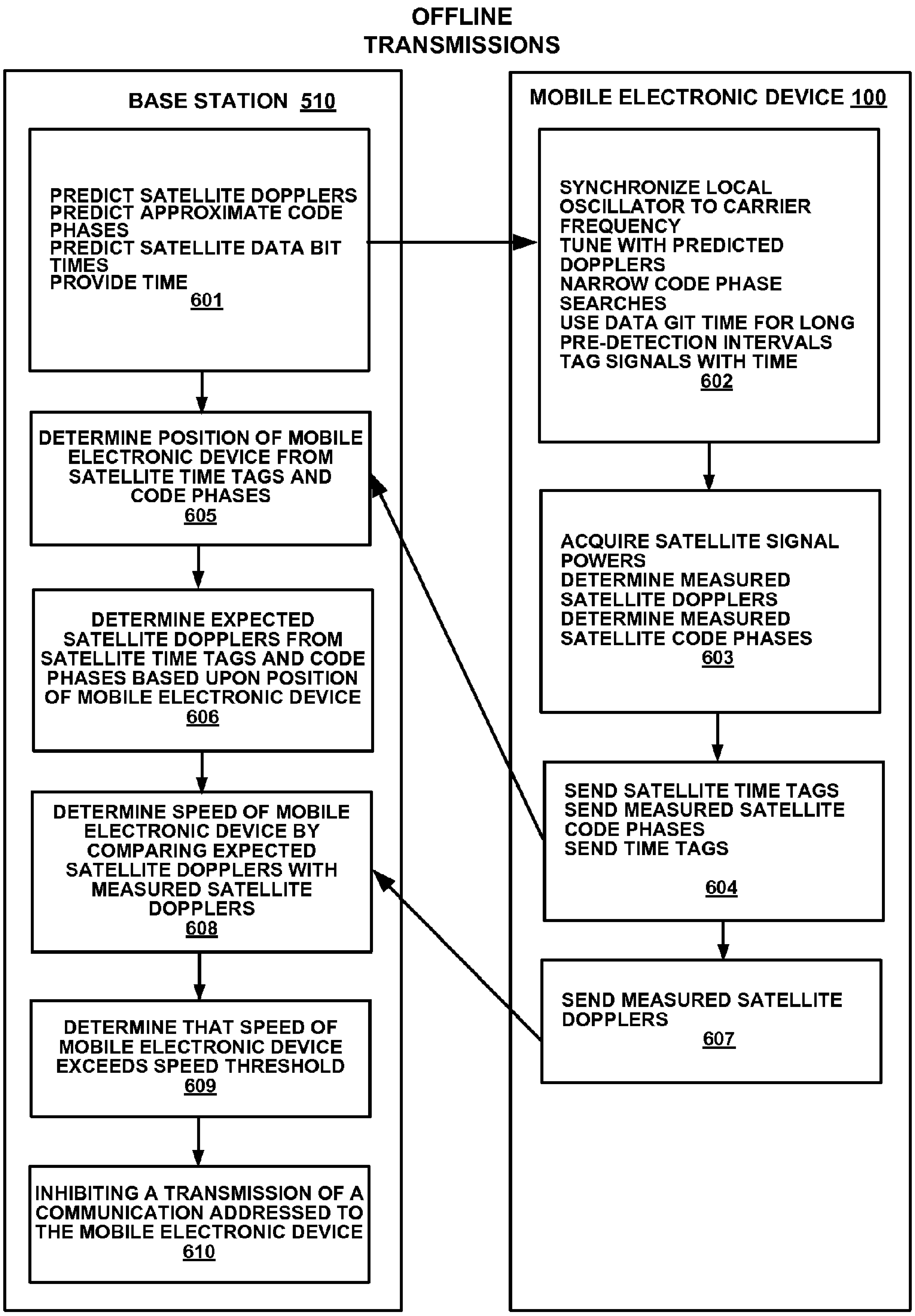
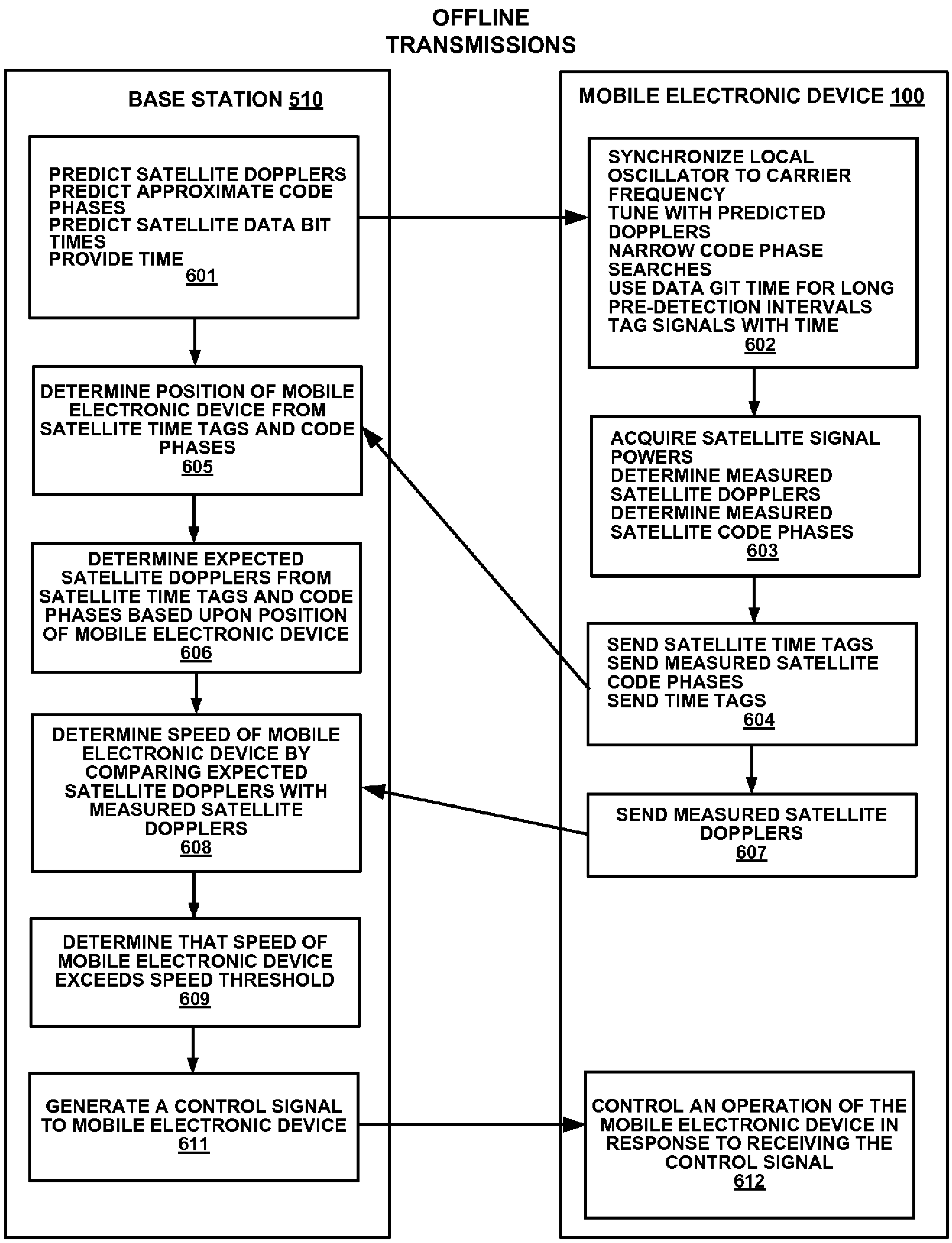

OFFLINE TRANSMISSIONS
BASE STATION 510
PREDICT SATELLITE DOPPLERS
PREDICT APPROXIMATE CODE PHASES
PREDICT SATELLITE DATA BIT TIMES
PROVIDE TIME
601
DETERMINE POSITION OF MOBILE ELECTRONIC DEVICE FROM SATELLITE TIME TAGS AND CODE PHASES
605
DETERMINE EXPECTED SATELLITE DOPPLERS FROM SATELLITE TIME TAGS AND CODE PHASES BASED UPON POSITION OF MOBILE ELECTRONIC DEVICE
606
DETERMINE SPEED OF MOBILE ELECTRONIC DEVICE BY COMPARING EXPECTED SATELLITE DOPPLERS WITH MEASURED SATELLITE DOPPLERS
608
DETERMINE THAT SPEED OF MOBILE ELECTRONIC DEVICE EXCEEDS SPEED THRESHOLD
609
INHIBITING A TRANSMISSION OF A COMMUNICATION ADDRESSED TO THE MOBILE ELECTRONIC DEVICE
610
MOBILE ELECTRONIC DEVICE 100
SYNCHRONIZE LOCAL OSCILLATOR TO CARRIER FREQUENCY
TUNE WITH PREDICTED DOPPLERS
NARROW CODE PHASE SEARCHES
USE DATA GIT TIME FOR LONG PRE-DETECTION INTERVALS
TAG SIGNALS WITH TIME
602
ACQUIRE SATELLITE SIGNAL POWERS
DETERMINE MEASURED SATELLITE DOPPLERS
DETERMINE MEASURED SATELLITE CODE PHASES
603
SEND SATELLITE TIME TAGS
SEND MEASURED SATELLITE CODE PHASES
SEND TIME TAGS
604
SEND MEASURED SATELLITE DOPPLERS
607

FIG. 6A


OFFLINE
TRANSMISSIONS
BASE STATION 510
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PREDICT APPROXIMATE CODE PHASES
PREDICT SATELLITE DATA BIT TIMES
PROVIDE TIME
601
DETERMINE POSITION OF MOBILE ELECTRONIC DEVICE FROM SATELLITE TIME TAGS AND CODE PHASES
605
DETERMINE EXPECTED SATELLITE DOPPLERS FROM SATELLITE TIME TAGS AND CODE PHASES BASED UPON POSITION OF MOBILE ELECTRONIC DEVICE
606
DETERMINE SPEED OF MOBILE ELECTRONIC DEVICE BY COMPARING EXPECTED SATELLITE DOPPLERS WITH MEASURED SATELLITE DOPPLERS
608
DETERMINE THAT SPEED OF MOBILE ELECTRONIC DEVICE EXCEEDS SPEED THRESHOLD
609
GENERATE A CONTROL SIGNAL TO MOBILE ELECTRONIC DEVICE
611
MOBILE ELECTRONIC DEVICE 100
SYNCHRONIZE LOCAL OSCILLATOR TO CARRIER FREQUENCY
TUNE WITH PREDICTED DOPPLERS
NARROW CODE PHASE SEARCHES
USE DATA GIT TIME FOR LONG PRE-DETECTION INTERVALS
TAG SIGNALS WITH TIME
602
ACQUIRE SATELLITE SIGNAL POWERS
DETERMINE MEASURED SATELLITE DOPPLERS
DETERMINE MEASURED SATELLITE CODE PHASES
603
SEND SATELLITE TIME TAGS
SEND MEASURED SATELLITE CODE PHASES
SEND TIME TAGS
604
SEND MEASURED SATELLITE DOPPLERS
607
CONTROL AN OPERATION OF THE MOBILE ELECTRONIC DEVICE IN RESPONSE TO RECEIVING THE CONTROL SIGNAL
612

FIG. 6B

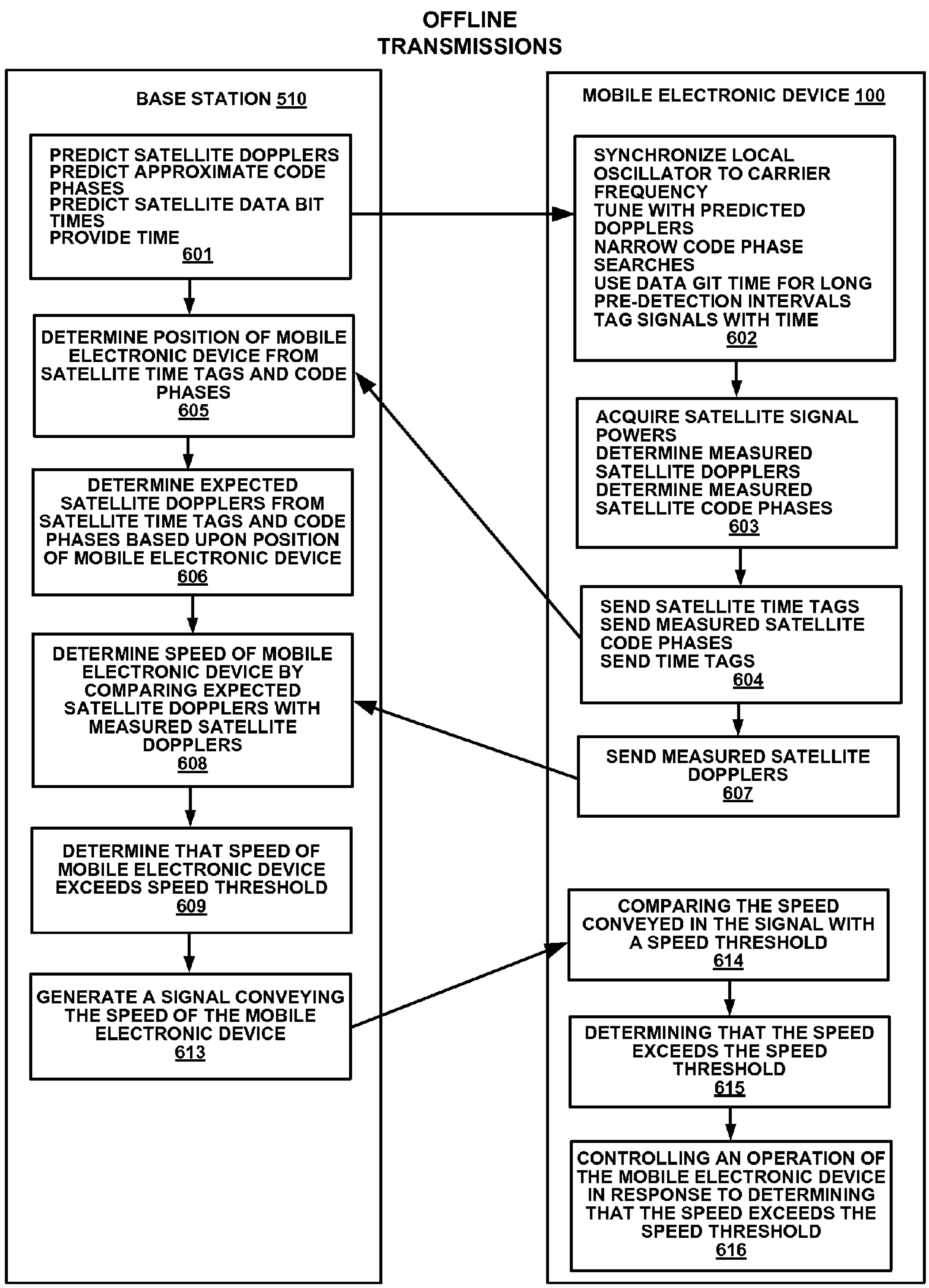
OFFLINE TRANSMISSIONS
BASE STATION 510
PREDICT SATELLITE DOPPLERS
PREDICT APPROXIMATE CODE PHASES
PREDICT SATELLITE DATA BIT TIMES
PROVIDE TIME
601
DETERMINE POSITION OF MOBILE ELECTRONIC DEVICE FROM SATELLITE TIME TAGS AND CODE PHASES
605
DETERMINE EXPECTED SATELLITE DOPPLERS FROM SATELLITE TIME TAGS AND CODE PHASES BASED UPON POSITION OF MOBILE ELECTRONIC DEVICE
606
DETERMINE SPEED OF MOBILE ELECTRONIC DEVICE BY COMPARING EXPECTED SATELLITE DOPPLERS WITH MEASURED SATELLITE DOPPLERS
608
DETERMINE THAT SPEED OF MOBILE ELECTRONIC DEVICE EXCEEDS SPEED THRESHOLD
609
GENERATE A SIGNAL CONVEYING THE SPEED OF THE MOBILE ELECTRONIC DEVICE
613
MOBILE ELECTRONIC DEVICE 100
SYNCHRONIZE LOCAL OSCILLATOR TO CARRIER FREQUENCY
TUNE WITH PREDICTED DOPPLERS
NARROW CODE PHASE SEARCHES
USE DATA GIT TIME FOR LONG PRE-DETECTION INTERVALS
TAG SIGNALS WITH TIME
602
ACQUIRE SATELLITE SIGNAL POWERS
DETERMINE MEASURED SATELLITE DOPPLERS
DETERMINE MEASURED SATELLITE CODE PHASES
603
SEND SATELLITE TIME TAGS
SEND MEASURED SATELLITE CODE PHASES
SEND TIME TAGS
604
SEND MEASURED SATELLITE DOPPLERS
607
COMPARING THE SPEED CONVEYED IN THE SIGNAL WITH A SPEED THRESHOLD
614
DETERMINING THAT THE SPEED EXCEEDS THE SPEED THRESHOLD
615
CONTROLLING AN OPERATION OF THE MOBILE ELECTRONIC DEVICE IN RESPONSE TO DETERMINING THAT THE SPEED EXCEEDS THE SPEED THRESHOLD
616

FIG. 6C

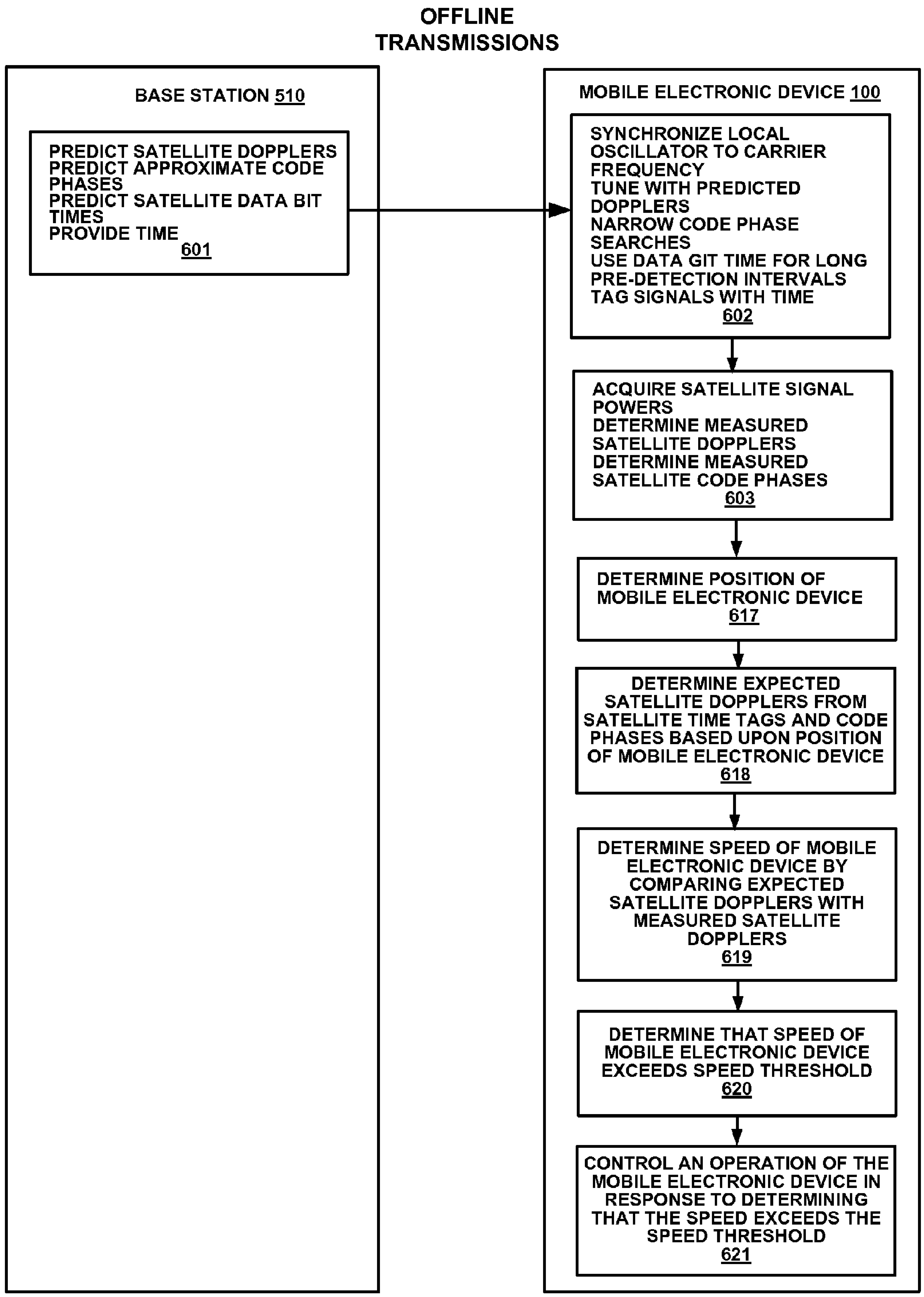
OFFLINE
TRANSMISSIONS
BASE STATION 510
PREDICT SATELLITE DOPPLERS
PREDICT APPROXIMATE CODE PHASES
PREDICT SATELLITE DATA BIT TIMES
PROVIDE TIME
601
MOBILE ELECTRONIC DEVICE 100
SYNCHRONIZE LOCAL OSCILLATOR TO CARRIER FREQUENCY
TUNE WITH PREDICTED DOPPLERS
NARROW CODE PHASE SEARCHES
USE DATA GIT TIME FOR LONG PRE-DETECTION INTERVALS
TAG SIGNALS WITH TIME
602
ACQUIRE SATELLITE SIGNAL POWERS
DETERMINE MEASURED SATELLITE DOPPLERS
DETERMINE MEASURED SATELLITE CODE PHASES
603
DETERMINE POSITION OF MOBILE ELECTRONIC DEVICE
617
DETERMINE EXPECTED SATELLITE DOPPLERS FROM SATELLITE TIME TAGS AND CODE PHASES BASED UPON POSITION OF MOBILE ELECTRONIC DEVICE
618
DETERMINE SPEED OF MOBILE ELECTRONIC DEVICE BY COMPARING EXPECTED SATELLITE DOPPLERS WITH MEASURED SATELLITE DOPPLERS
619
DETERMINE THAT SPEED OF MOBILE ELECTRONIC DEVICE EXCEEDS SPEED THRESHOLD
620
CONTROL AN OPERATION OF THE MOBILE ELECTRONIC DEVICE IN RESPONSE TO DETERMINING THAT THE SPEED EXCEEDS THE SPEED THRESHOLD
621

FIG. 6D

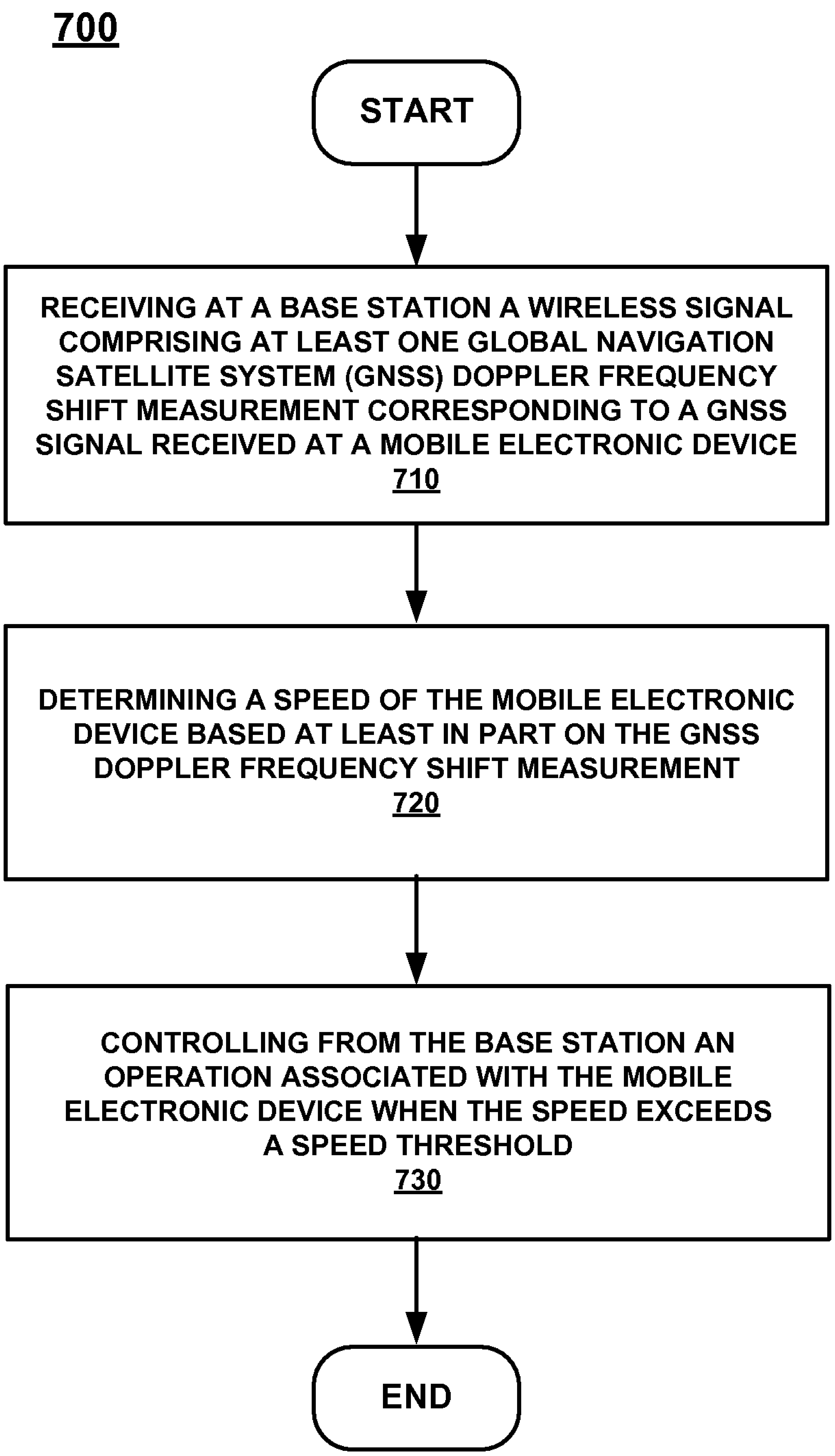
700
START
RECEIVING AT A BASE STATION A WIRELESS SIGNAL COMPRISING AT LEAST ONE GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) DOPPLER FREQUENCY SHIFT MEASUREMENT CORRESPONDING TO A GNSS SIGNAL RECEIVED AT A MOBILE ELECTRONIC DEVICE
710
DETERMINING A SPEED OF THE MOBILE ELECTRONIC DEVICE BASED AT LEAST IN PART ON THE GNSS DOPPLER FREQUENCY SHIFT MEASUREMENT
720
CONTROLLING FROM THE BASE STATION AN OPERATION ASSOCIATED WITH THE MOBILE ELECTRONIC DEVICE WHEN THE SPEED EXCEEDS A SPEED THRESHOLD
730
END

FIG. 7

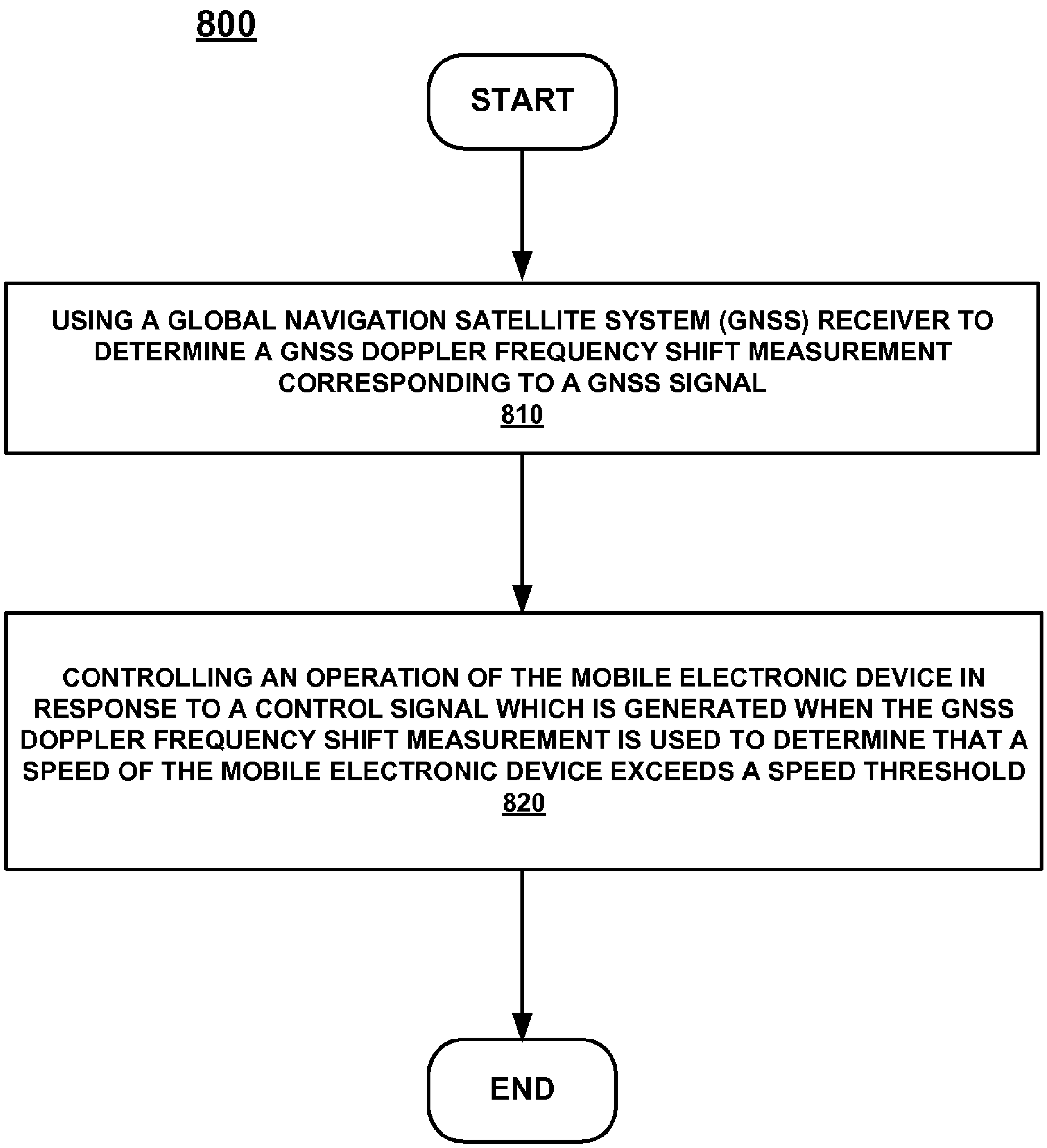
800
START
USING A GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) RECEIVER TO DETERMINE A GNSS DOPPLER FREQUENCY SHIFT MEASUREMENT CORRESPONDING TO A GNSS SIGNAL
810
CONTROLLING AN OPERATION OF THE MOBILE ELECTRONIC DEVICE IN RESPONSE TO A CONTROL SIGNAL WHICH IS GENERATED WHEN THE GNSS DOPPLER FREQUENCY SHIFT MEASUREMENT IS USED TO DETERMINE THAT A SPEED OF THE MOBILE ELECTRONIC DEVICE EXCEEDS A SPEED THRESHOLD
820
END

FIG. 8

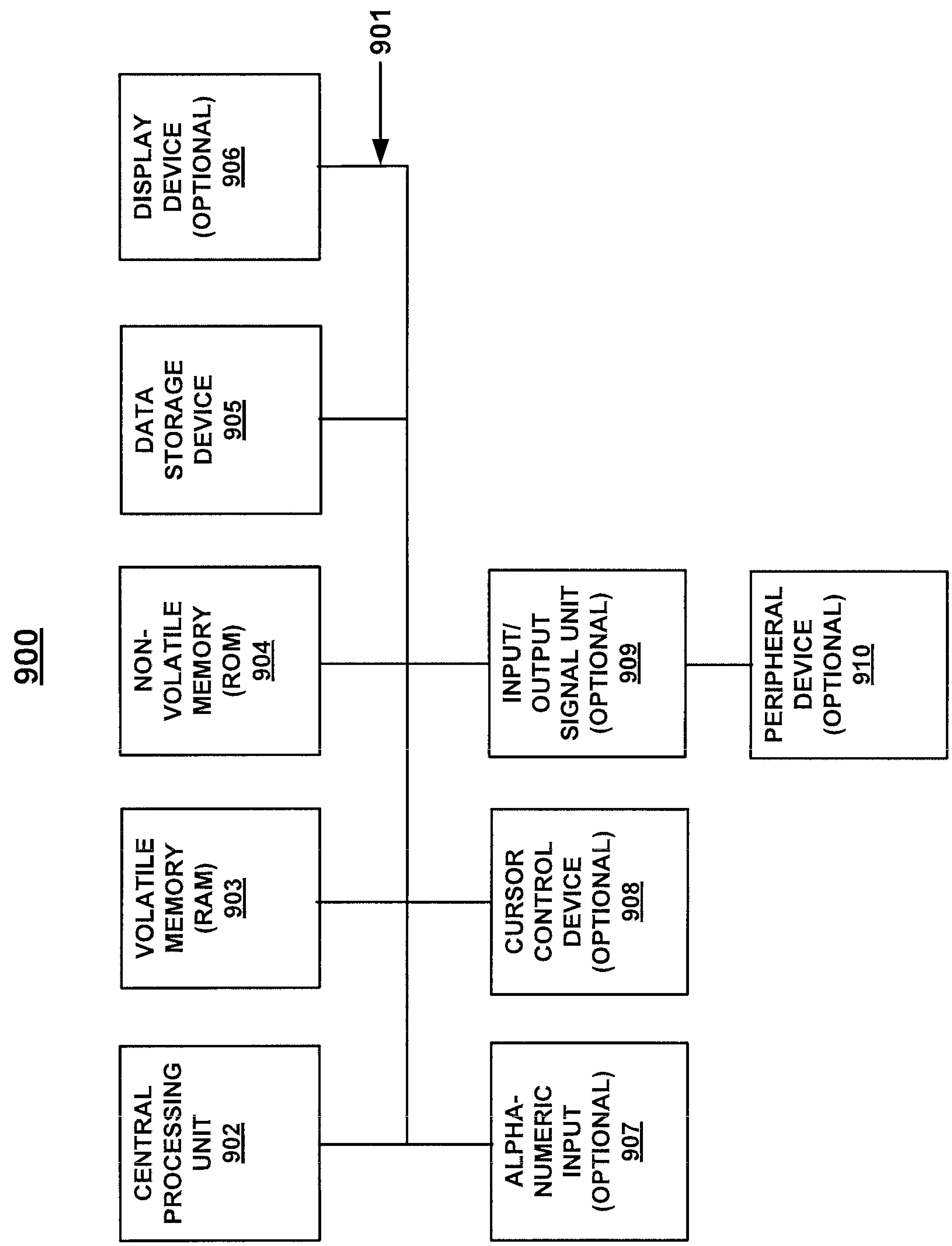
900
901
CENTRAL PROCESSING UNIT 902
VOLATILE MEMORY (RAM) 903
NON-VOLATILE MEMORY (ROM) 904
DATA STORAGE DEVICE 905
DISPLAY DEVICE (OPTIONAL) 906
ALPHA-NUMERIC INPUT (OPTIONAL) 907
CURSOR CONTROL DEVICE (OPTIONAL) 908
INPUT/ OUTPUT SIGNAL UNIT (OPTIONAL) 909
PERIPHERAL DEVICE (OPTIONAL) 910

FIG. 9

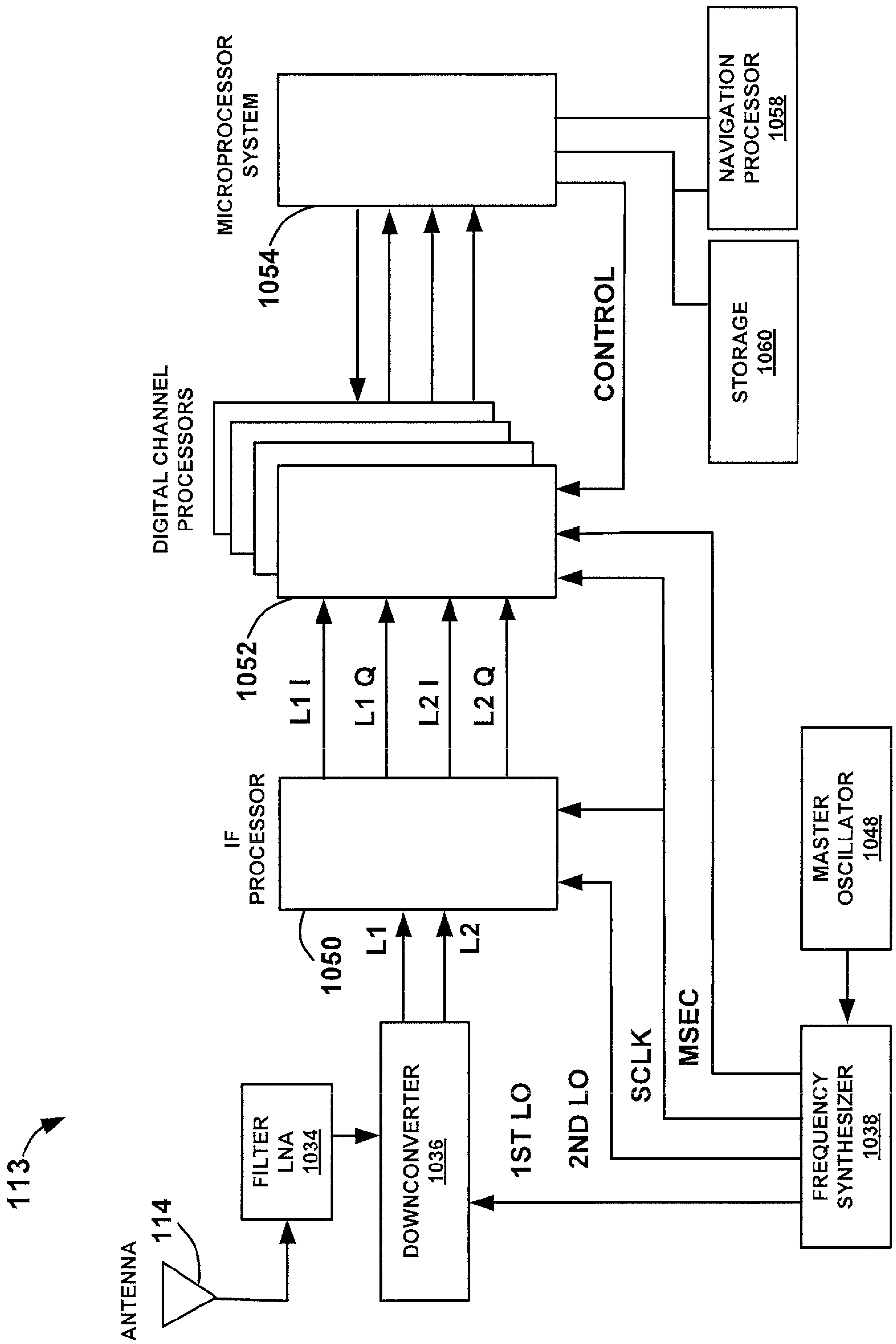
113
ANTENNA
114
FILTER
LNA
1034
DOWNCONVERTER
1036
1ST LO
2ND LO
SCLK
MSEC
FREQUENCY
SYNTHESIZER
1038
MASTER
OSCILLATOR
1048
L1
L2
1050
IF
PROCESSOR
L1 I
L1 Q
L2 I
L2 Q
1052
DIGITAL CHANNEL
PROCESSORS
CONTROL
1054
MICROPROCESSOR
SYSTEM
STORAGE
1060
NAVIGATION
PROCESSOR
1058

FIG. 10

METHOD AND COMMUNICATION SYSTEM FOR LIMITING THE FUNCTIONALITY OF AN ELECTRONIC DEVICE

FIELD OF THE INVENTION

Embodiments of the present invention are related to the field of controlling the functionality of mobile electronic devices.

RELATED APPLICATIONS

U.S. patent application Ser. No. 12/140,889 entitled "System Having Doppler-based Control of a Mobile Device," by David Gildea, assigned to the assignee of the present invention, filed Jun. 17, 2008, and which is incorporated by reference in its entirety herein.

BACKGROUND OF THE INVENTION

Driver distractions are currently a leading cause of traffic accidents. Of particular concern are drivers who operate mobile electronic devices (e.g., cellular telephones, Personal Digital Assistants (PDAs) and the like) while driving. Many people feel that drivers who are talking on a cellular telephone are particularly prone to accidents or careless driving. This is especially true of teenage drivers who do not have the level of experience of older drivers. Talking on cellular telephones is not the only distraction that drivers face. Attempting to dial a phone number, access or send text messages, or operate the user interface in general are particularly dangerous as the driver typically is looking at the cellular telephone rather than the road.

SUMMARY OF THE INVENTION

Embodiments of the present invention recite a method and system for limiting the functionality of a mobile electronic device. In one embodiment, a Global Navigation Satellite System (GNSS) receiver configured to determine a GNSS Doppler frequency shift measurement corresponding to a GNSS signal. A control component is configured to control an operation of the mobile electronic device in response to a control signal which is generated when the GNSS Doppler frequency shift measurement is used to determine that the speed of the mobile electronic device exceeds a speed threshold.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of this specification, illustrate embodiments of the present invention and, together with the description, serve to explain the principles of the invention. Unless specifically noted, the drawings referred to in this description should be understood as not being drawn to scale.

FIG. **1** is a block diagram of a mobile electronic device upon which embodiments of the present invention may be implemented.

FIG. **2** is a flowchart of a method for limiting the functionality of a mobile electronic device in accordance with embodiments of the present invention.

FIG. **3** is a block diagram of a control component utilized in accordance with embodiments of the present invention.

FIG. **4** shows a communication system and base station in accordance with an embodiment of the present invention.

FIG. **5** is a block diagram of components of base station in accordance with an embodiment of the present invention.

FIGS. **6**A, **6**B, **6**C and **6**D are flowcharts showing sequences of events performed by a communication system in accordance with embodiments of the present invention.

FIG. **7** is a flowchart of a method for limiting the functionality of an electronic device in accordance with embodiments of the present invention.

FIG. **8** is a flowchart of a method for limiting the functionality of a communication device in accordance with embodiments of the present invention.

FIG. **9** is a block diagram of an exemplary computer system upon which embodiments of the present invention may be implemented.

FIG. **10** is a block diagram of an example satellite navigation receiver used in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will now be made in detail to embodiments of the present invention, examples of which are illustrated in the accompanying drawings. While the present invention will be described in conjunction with the following embodiments, it will be understood that they are not intended to limit the present invention to these embodiments alone. On the contrary, the present invention is intended to cover alternatives, modifications, and equivalents which may be included within the spirit and scope of the present invention as defined by the appended claims. Furthermore, in the following detailed description of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, embodiments of the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail so as not to unnecessarily obscure aspects of the present invention.

Notation and Nomenclature

Some portions of the detailed descriptions which follow are presented in terms of procedures, logic blocks, processing and other symbolic representations of operations on data bits within a computer memory. These descriptions and representations are the means used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. In the present application, a procedure, logic block, process, or the like, is conceived to be a self-consistent sequence of steps or instructions leading to a desired result. The steps are those requiring physical manipulations of physical quantities. Usually, although not necessarily, these quantities take the form of electrical or magnetic signal capable of being stored, transferred, combined, compared, and otherwise manipulated in a computer system.

It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the following discussions, it is appreciated that throughout the present invention, discussions utilizing terms such as "using," "determining," "receiving," "controlling," "calculating," "comparing," "comparing," "transmitting," "configuring," "inhibiting," "storing," "predicting" or the like, refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission or display devices.

With reference to FIG. **1**, portions of the present invention are comprised of executable instructions that reside, for example, in mobile electronic device **100**. In FIG. **1**, mobile electronic device **100** comprises a processor **101** coupled with an address/data bus **102**. Processor **101** is for processing digital information and instructions and bus **102** is for conveying digital information between various components of mobile electronic device **100**. Also coupled with bus **102** is a volatile memory (e.g., RAM) **103** for storing the digital information and instructions of a more volatile nature and a non-volatile memory (e.g., ROM) **104** for storing information and instructions of a more permanent nature. In addition, mobile electronic device **100** may optionally include a data storage device **105** for storing vast amounts of data. In embodiments of the present invention, data storage device **105** may comprise a magnetic data storage device, or optical data storage device. It should be noted that instructions for processor **101** can be stored in non-volatile memory **104**, volatile memory **103**, or data storage device **105**.

Returning still to FIG. **1**, mobile electronic device **100** further comprises a display device **106**, an alpha-numeric input device **107** (e.g., a keyboard), or a keypad, and an optional cursor control device **108** (e.g., mouse, trackball, light pen, wheel, etc.) for inputting data, selections, updates, etc. Display device **106** of FIG. **1** may be a liquid crystal device, or other display device suitable for creating graphic images and alpha-numeric characters recognizable to a user. In one embodiment, display device **106** may display an alpha-numeric interface which can be used to implement a "soft-key" functionality. Cursor control device **108** allows a user to dynamically signal the two dimensional movement of a visible symbol (cursor) on a display screen of display device **106**. Many implementations of cursor control device **108** are known in the art including a trackball, mouse, touch pad, joystick, or special keys capable of signaling movement of a given direction or manner displacement. Alternatively, it will be appreciated that a cursor can be directed and/or activated via input from alpha-numeric input **107** using special keys and key sequence commands. Alternatively, the cursor may be directed and/or activated via input from a number of specially adapted cursor directing devices.

Returning to FIG. **1**, mobile electronic device **100** further comprises a wireless communication system **109**, comprising a wireless modem **110** and a wireless antenna **111**, coupled with bus **102**. A GNSS system **112**, comprising a GNSS receiver **113** and a GNSS antenna **114**, is also coupled with bus **102**.

Wireless communication system **109** is for transmitting and receiving wireless messages (e.g., data and/or commands). In one embodiment, mobile electronic device **100** sends and receives message using the Short Message Service (SMS). However, mobile electronic device **100** is well suited to utilize other message formats as well such as the Global System for Mobile Communications (GSM) specification, or the Global Packet Radio Service (GPRS) specification. In one embodiment, wireless communications system **109** is compliant with a Code Division Multiple Access (CDMA) communication standard, or a variant thereof. Variants of the CDMA standard include, but are not limited to the CDMA-2000 standard, the WCDMA standard, the HSPDA standard, the TD-CDMA standard, and the cdmaOne standard. In another embodiment, wireless communication system **109** is compliant with the Time Division Multiple Access (TDMA) standard. In another embodiment, wireless communication system **109** is compliant with the Integrated Digital Enhanced Network (iDEN) specification. Additionally, an embodiment of the present invention is well suited to implement potential 4G networks such as the Worldwide Interoperability for Microwave Access (WiMax) technology and the 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE) technology.

GNSS system **112** is for acquiring signals used in determining the location of mobile electronic device **100**. In FIG. **1**, position determining component **112** comprises a GNSS antenna **114** and a GNSS receiver **113**. However, mobile electronic device **100** is not limited to using a GNSS position determining system alone. For example, GNSS system **112** may also use cellular telephone signals, digital television signals, terrestrial-based navigation systems, inertial navigation systems, etc. to assist in determining its location.

In FIG. **1**, mobile electronic device **100** further comprises a communication interface **115** which is coupled with bus **102**. In one embodiment, communication interface **115** is communicatively coupled with a headset **120** comprising a microphone **121** and an earpiece **122**. In one embodiment, headset **120** is communicatively coupled with communication interface **115** via a wireless communication system such as the Bluetooth® system. In another embodiment, headset **120** is coupled with communication interface **115** via a wired connection.

Also shown in FIG. **1** is an automotive Bluetooth® system **130** which is communicatively coupled with communication interface **115**. In embodiments of the present invention, mobile electronic device **100** may be communicatively coupled with automotive Bluetooth® system **130** which permits a user to operate, for example, a cellular telephone using voice commands while operating a moving vehicle. Automotive Bluetooth® system **130** typically synchronizes with mobile electronic device **100** via a Bluetooth® system local network and interprets a user's voice commands to control mobile electronic device **100** via a Bluetooth® connection.

Also shown in FIG. **1** is a control component **150** stored in volatile memory **103**. As will be discussed in greater detail below, control component **150** is for limiting the functionality of mobile electronic device **100** when the speed of mobile electronic device **100** exceeds a speed threshold. In the embodiment of FIG. **1**, control component **150** comprises computer executable instructions which are loaded into volatile memory **103** when mobile electronic device **100** is powered on. In another embodiment, control component **150** can be implemented as one or more discreet hardware components resident upon mobile electronic device **100**. Alternatively, control component **150** can be implemented as one or more computer firmware components.

Also shown in FIG. **1** is a speed determiner **160**. Speed determiner **160** is used to determine the speed of mobile electronic device based upon processing of signals received by GNSS system **112**. It is noted that the functionality of components of speed determiner **160** can be implemented as executable instructions stored in, for example, volatile memory **103**. In FIG. **1**, speed determiner **160** comprises a comparator **161**, a position determiner **162**, a relative measurement calculator **163**, and a control signal generator **164**. Comparator **161** is configured to compare expected GNSS Doppler frequency shifts at the position of mobile electronic device **100** with measured GNSS Doppler frequency shifts received by GNSS system **112**. Position determiner **162** is configured to determine the geographic position of mobile electronic device **100** using signals received by GNSS system **112**. Relative measurement calculator **163** is configured to calculate a plurality of measured range rates corresponding to a plurality of GNSS Doppler frequency shift measurements, and to calculate a plurality of expected range rates between mobile electronic device **100** and a plurality of GNSS satellites. The operation of speed determiner **160** is described in greater detail below with reference to speed determiner **533** of FIG. **5**.

FIG. **2** is a flowchart of a method **200** for limiting the functionality of a mobile electronic device (e.g., mobile electronic device **100** of FIG. **1**) in accordance with embodiments of the present invention. In embodiments of the present invention, method **200** is implemented by control component **150** of FIG. **1**. In step **210** of FIG. **2**, a GNSS system disposed within a mobile electronic device is used to assist in determining the speed of the mobile electronic device. Referring again to FIG. **1**, embodiments of the present invention utilize a GNSS system **112** disposed within mobile electronic device **100** to acquire signals from a plurality of orbiting navigation satellites. Processing these signals facilitates determining the geographic position and speed of mobile electronic device **100**. For example, in one embodiment, successive position fixes determined by GNSS system **112**, as well as the time interval between these position fixes, can be used to determine the speed of mobile electronic device **100** for a given period. In other words, the distance traveled by mobile electronic device **100** over a period of time is determined. In another embodiment, evaluation of the Doppler shift of the signals from the orbiting navigation satellites facilitates determining the speed of mobile electronic device **100**.

Embodiments of the present invention benefit from the increasing integration of position determining components, such as GNSS system **112**, into mobile electronic devices. As an example, cellular telephones increasingly integrate Global Positioning System (GPS) or other GNSS devices to comply with the Wireless Enhanced 911 service. Other mobile electronic devices such as Personal Digital Assistants (PDAs) or the like also increasingly integrate GNSS devices as well. Thus, embodiments of the present invention take advantage of this integration to determine the speed of mobile electronic device **100**. It is noted that embodiments of the present invention are not limited to GNSS position determining systems alone. For example, GNSS system **112** can use cellular telephone signals, digital television signals, terrestrial-based navigation systems, inertial navigation systems, etc.

In step **220** of FIG. **2**, it is determined that the speed of the mobile electronic device exceeds a speed threshold. In one embodiment, the determination of the speed of mobile electronic device **100** is performed by speed determiner **160** of FIG. **1**. In another embodiment, the determination of the speed of mobile electronic device **100** is performed by base station **510** of FIG. **4**. In embodiments of the present invention, a speed threshold is established which is used to determine if mobile electronic device **100** is being operated while in a moving vehicle. For example, the speed threshold of mobile electronic device can be set at 8 miles per hour. Thus, if it is determined that mobile electronic device **100** has a speed of 9 miles per hour, it is assumed that it is being operated by a user in a moving vehicle. It is noted that the speed threshold may be set higher or lower than 8 miles per hour in embodiments of the present invention. More generally, the speed threshold set for mobile electronic device **100** will be set higher than the normal walking or running speed of a human in order to be able to conclusively establish that mobile electronic device **100** is being operated in a moving vehicle, or at a speed at which it is desirable that the user not be distracted by operating mobile electronic device **100**. In embodiments of the present invention, the geographic position of mobile electronic device **100** can be compared with an electronic map to determine whether mobile electronic device **100** is being operated in a moving vehicle on a road. For example, in one embodiment, the satellite navigation signals received by GNSS system **112** can also be used to determine the altitude at which mobile electronic device is located. Thus, if it is determined that mobile electronic device **100** is at an altitude of 10,000 feet above a road, an embodiment of the present invention determines that the functionality of mobile electronic device **100** may continue without restriction. Additionally, if the comparison of the current geographic location of mobile electronic device **100** shows that it is in the middle of a lake or river, an embodiment of the present invention may allow the functionality of mobile electronic device **100** to continue without restriction. Thus, embodiments of the present invention can differentiate between whether mobile electronic device **100** is being operated in a boat, or airplane, rather than a moving vehicle.

In step **230** of FIG. **2**, the functionality of the mobile electronic device **100** is restricted based upon determining that its speed exceeds the speed threshold. In embodiments of the present invention, upon establishing that mobile electronic device **100** is being operated in a moving vehicle, the functionality of mobile electronic device **100** is restricted in order to get a user to stop using mobile electronic device in the moving vehicle. Alternatively, the functionality of mobile electronic device **100** may be automatically restricted such that operating it in a moving vehicle is undesirable, or impossible. As will be discussed in greater detail below, in one embodiment, base station **510** can inhibit the transmission of a communication addressed to mobile electronic device. Additionally, base station **510** can prevent a communication from mobile electronic device **100** from being forwarded to another communication node.

In one embodiment, base station **510** is configured to generate a control signal **590** which indicates that the speed of mobile electronic device **100** exceeds a speed threshold. In response to receiving control signal **590**, control component **150** of mobile electronic device **100** will automatically control an operation of mobile electronic device **100**. For example, the keypad can be disabled to prevent a user from using mobile electronic device **100** to send or receive messages. In one embodiment, mobile electronic device may be shut off in response to receiving control signal **590**. Other operations which can be controlled in accordance with embodiments of the present invention are discussed in greater detail below. In one embodiment, a message is also generated to a user of mobile electronic device **100** that it cannot be operated because its speed exceeds the speed threshold. For example, if a user tries to make a cellular telephone call using mobile electronic device **100** while its speed exceeds the speed threshold, an audible signal and/or a displayed message will indicate that mobile electronic device **100** cannot be operated.

In another embodiment, when base station **510** generates control signal **590** mobile electronic device **100** initiates an action to control an operation of mobile electronic device **100**. For example, in response to control signal **590**, control component **150** will prevent a using mobile electronic device **100** from generating, or receiving, a message. In another embodiment, base station **510** will generate control signal **590** which conveys to mobile electronic device **100** its current speed. In one embodiment, mobile electronic device **100** then determines whether it is exceeding a speed threshold using control component **150**. If mobile electronic device **100** determines that it is exceeding a speed threshold, it will automatically control an operation of mobile electronic device **100**. Again, the control of operations of mobile electronic device **100** in accordance with embodiments of the present invention are discussed in greater detail below.

In another embodiment, mobile electronic device **100** is configured to determine its speed using speed determiner **160**. When speed determiner **160** determines that the speed of mobile electronic device **100** exceeds a speed threshold, it generates a control signal using control signal generator **164**. In one embodiment, control component **150** controls an operation of mobile electronic device **100** in response to the control signal generated by control signal generator **164** as discussed in greater detail below.

In one embodiment, mobile electronic device **100** is automatically shut off in response to determining that its speed exceeds the speed threshold. In another embodiment, an audible warning is generated in response to determining that the speed of mobile electronic device **100** exceeds the speed threshold. In one embodiment, the audible warning comprises a beep or tone to remind the user that the speed threshold has been exceeded and to take corrective action (e.g., to pull off the road, terminate the current operation, etc). In one embodiment, the audible warning becomes progressively louder each time it is repeated until corrective action is performed. In another embodiment, the audible warning comprises a verbal warning that the speed of mobile electronic device **100** exceeds the speed threshold. In another embodiment, the audible warning comprises a continuous tone which reminds the user that mobile electronic device should not be operated. In one embodiment the continuous tone is loud enough to prevent a user from being able to continue a conversation using mobile electronic device **100**.

In one embodiment, the display of mobile electronic device shows a warning that mobile electronic device **100** is being operated at an unsafe speed. In one embodiment, no other text, data, graphics, or the like is displayed on display device **106** until the speed of mobile electronic device is again below the speed threshold.

In one embodiment, the operation of a keypad (e.g., alphanumeric input device **107** of FIG. **1**) is restricted until it is determined that the speed of mobile electronic device **100** again falls below the speed threshold. In one embodiment, restricting the keypad of mobile electronic device **100** comprises not processing any sequences input using the keypad. In other words, the keypad is disabled. In one embodiment, some key sequences are allowed to be processed using the keypad. For example, a user can dial 911 even if the speed of mobile electronic device exceeds the speed threshold in one embodiment. In another embodiment, a user can use the speed dialing functionality of mobile electronic device **100**. This is because many users can enter short numeric sequences with a keypad without undue distraction from driving. In other words, the user may be entering the sequence by feeling the buttons of the keypad alone. In one embodiment, the allowed key sequence may be pre-determined. For example, a parent can have mobile electronic device **100** configured such that their children can speed dial them, but are prevented from speed dialing their friends or other parties while the speed of mobile electronic device exceeds the speed threshold. In one embodiment, the allowed key sequence can be restricted to single digit speed dialing numbers, two digit speed dialing numbers, etc.

Thus, embodiments of the present invention are well suited to preventing drivers from performing actions which may distract them from operating a vehicle safely. For example, in one embodiment a user is restricted from trying to manually dial a phone number, or send a text message, if the vehicle in which they are riding is traveling faster than the speed threshold. Furthermore, embodiments of the present invention may progressively increase the level of functionality restriction imposed upon mobile electronic device **100** if a user continues to operate it while in a moving vehicle. For example, if a user continues to operate mobile electronic device **100** after an audible warning has been generated, one embodiment will automatically shut down mobile electronic device **100**. In another embodiment, operation of mobile electronic device **100** is suspended until the speed of mobile electronic device **100** is again below the speed threshold. In other words, mobile electronic device **100** remains powered on, but the user is unable to utilize it until its speed again falls below the speed threshold.

In one embodiment, restricting the functionality of mobile electronic device **100** comprises permitting incoming cellular telephone calls, but preventing a user from making any outgoing calls. This prevents the user from being distracted by operating mobile electronic device **100**. Thus, if an incoming call arrives, the user can simply press one button to connect the call. In one embodiment, the incoming phone call is restricted to certain permitted originators. For example, a parent can have mobile electronic device **100** configured such that their children can receive a phone call from the parent, but not from friends of the children or other parties. However, if the phone call is not from a permitted originator, the phone call is automatically terminated. Alternatively, the phone call may be automatically redirected to a voice mail system. In one embodiment, if a phone call originated prior to determining that the speed of mobile electronic device **100** has exceeded the speed threshold, the phone call is allowed to continue until the user has terminated the phone call.

In one embodiment, mobile electronic device **100** determines whether a user is utilizing a hands free device (e.g., headset **120**, or automotive Bluetooth® system **130** of FIG. **1**). If a hands free device is not being used to operate mobile electronic device **100**, any of the above mentioned restrictions, or a combination thereof, may be automatically performed in accordance with embodiments of the present invention. This is desirable due to the fact that many states have passed, or are considering, legislation requiring drivers to user hands free devices when operating a cellular telephone in a moving vehicle. Thus, embodiments of the present invention facilitate compliance with mandated requirements regarding the operation of cellular telephones.

In one embodiment, a voice activation system may be required in accordance with embodiments of the present invention. Voice activation systems allow a user to speak a command which is then executed by, for example, mobile electronic device **100**. Thus, rather than using alpha-numeric input device **107** to dial a number, the user can simply speak the telephone number, or say the name of the party being dialed. In embodiments of the present invention, if a voice activation system is not utilized with mobile electronic device **100**, any of the above mentioned restrictions, or a combination thereof, may be automatically performed in accordance with embodiments of the present invention. In one embodiment, an outgoing phone call is restricted to certain permitted parties. For example, a parent can have mobile electronic device **100** configured such that their children can call their parent, but not call friends of the children or other parties. Thus, if the outgoing phone call is not to an allowed party, the phone call is terminated.

Embodiments of the present invention may be implemented voluntarily, or in response to a mandated requirement (e.g., a legislative restriction on the use of cellular telephones or other mobile electronic devices). For example, a parent purchasing a cellular telephone (e.g., mobile electronic device **100**) for a child may voluntarily choose to use embodiments of the present invention to limit how or when the cellular telephone is used by their child. In one embodiment, when the cellular telephone is being configured (e.g., at a store), control component **150** is loaded into non-volatile memory **104**. When the cellular telephone is on, control component **150** is loaded into volatile memory **103** and is used to limit the functionality of the cellular telephone as described above. Thus, parents can take steps to prevent their children from using a cellular telephone while driving and thus operate the vehicle safely. Alternatively, any user may elect to implement an embodiment of the present invention as an added safety measure. Additionally, insurance companies may find it beneficial to offer rate discounts for drivers who implement embodiments of the present invention in their cellular telephones as an incentive.

Embodiments of the present invention may also be voluntarily implemented by, for example, a cellular telephone manufacturer, or cellular telephone service provider in order to unilaterally restrict the use of cellular telephones while the user is operating a vehicle. It is noted that embodiments of the present invention may also be implemented by manufacturers or service providers of other mobile electronic devices who are seeking to curtail or restrict the use of mobile electronic devices by users who are operating a vehicle.

Embodiments of the present invention may also be implemented in response to a mandated requirement to restrict the use of cellular telephone, or other mobile electronic devices, by users who are operating a vehicle. For example, if a legislative body passes a law requiring the restriction of mobile electronic devices by users who are operating a vehicle, embodiments of the present invention provide a method of complying with that requirement. Currently, while states have enacted legislation intended to prevent cell phone use by people driving vehicles, many people ignore these laws, or forget and use their cell phones anyway.

FIG. **3** is a block diagram of a control component **150** utilized in accordance with embodiments of the present invention. In the embodiment of FIG. **3**, control component **150** comprises a signal input **301**, a speed comparator **302** and a function controller **303**. In one embodiment, signal input **301** receives a control signal from, for example, base station **510** or speed determiner **160**. As discussed above, in one embodiment a control signal (e.g., **590**) comprises an indication of the speed of mobile electronic device **100**. In another embodiment, speed determiner **160** can generate a signal indicating the speed of mobile electronic device **100** which is received via signal input **301** and is accessed by speed comparator **302**. Speed comparator **302** is configured to determine when the speed of mobile electronic device **100** exceeds a speed threshold (e.g., **390** of FIG. **3**). For example, if speed threshold **390** is set at a speed of 8 miles per hour, it may be assumed that mobile electronic device **100** is being operated by a user in a moving vehicle when its speed exceeds 8 miles per hour. Alternatively, it may be assumed that the user of mobile electronic device **100** is engaged in an activity which requires a greater attention to safety. In one embodiment, when speed comparator **302** determines that the speed of mobile electronic device **100** exceeds speed threshold **390**, it generates a control signal to function controller **303**.

Function controller **303** is configured to restrict the functionality of mobile electronic device **100** based upon receiving a control signal which indicates that the speed of mobile electronic device **100** exceeds a speed threshold. In another embodiment, control signal **590** generated by base station **510** indicates that the speed of mobile electronic device **100** exceeds a speed threshold. Alternatively, speed determiner **160** of mobile electronic device **100** can generate a control signal when the speed of mobile electronic device **100** exceeds a speed threshold. It is noted that the control signal is not required to indicate the speed of mobile electronic device **100**. In other words, the control signal simply indicates that the speed of mobile electronic device **100** exceeds a speed threshold.

In the embodiment of FIG. **3**, control component **150** further comprises a geographic position input **304** which is coupled with position comparator **305**. Geographic position input **304** receives a current geographic position of mobile electronic device **100** from either of base station **510** or position determiner **162**. Position comparator **305** is for determining that the current geographic position of mobile electronic device **100** comprises a road. In one embodiment, position comparator **305** compares the current geographic position of mobile electronic device **100** with a map or database (not shown) which is stored upon mobile electronic device **100**. An indication generator **306** is for generating and indication that the current geographic position of mobile electronic device **100** comprises a road. In one embodiment, the indication generated by indication generator **306** is used by function controller **303** to restrict the functionality of mobile electronic device **100**.

In the embodiment of FIG. **3**, control component **150** further comprises an audible warning generator **307**. As described above with reference to FIG. **2**, a variety of audible warnings and/or messages may be generated in accordance with the present invention to remind a user that they are operating mobile electronic device **100** in an unsafe manner. In one embodiment, the audible warning may prevent a user from operating mobile electronic device **100** in a satisfactory manner when the speed of mobile electronic device **100** exceeds a speed threshold.

In the embodiment of FIG. **3**, control component **150** further comprises a keypad restrictor **308** for restricting the use of a keypad (e.g., alpha-numeric input device **107** of FIG. **1**). As described above with reference to FIG. **2**, embodiments of the present invention may prevent a user from using a keypad of mobile electronic device **100** in such a manner as to prevent using mobile electronic device **100** in a moving vehicle. As noted above, embodiments of the present invention may allow some functionality of the keypad such as allowing the dialing of emergency services (e.g., 911), approved speed dialing sequences, approved telephone numbers, or approved recipients of a phone call. Additionally, embodiments of the present invention may prevent a user from entering and/or sending text messages using keypad restrictor **308**.

In the embodiment of FIG. **3**, control component **150** further comprises an allowed key sequence database **309** and a key sequence verifier **310**. Allowed key sequence database **309** is for storing an allowed key sequence. As described above, control component **150** can be configured such that only allowed key sequences are permitted to be dialed when the speed of mobile electronic device **150** exceeds a speed threshold. This can comprise, for example, a one digit or two digit speed dialing sequence, or the phone number of an approved party. Key sequence verifier **310** is for verifying that the key sequence entered by a user when the speed of mobile electronic device **100** exceeds a speed threshold comprises a key sequence stored in allowed key sequence database **309**. In the embodiment of FIG. **3**, control component **150** further comprises a key sequence enabler **311** for permitting the input key sequence which has been verified by key sequence verifier **310** to be entered using the keypad and executed by mobile electronic device **100**.

In the embodiment of FIG. **3**, control component **150** further comprises a keypad disabler **312** for disabling the keypad of mobile electronic device **100** entirely in response to determining that the speed of mobile electronic device **100** exceeds a speed threshold.

In the embodiment of FIG. **3**, control component **150** further comprises a message restrictor **313** for restricting the use of mobile electronic device **100** to receiving incoming calls. In embodiments of the present invention, upon determining that the speed of mobile electronic device **100** exceeds a speed threshold, message restrictor **313** permits incoming telephone calls to be received. In one embodiment, message restrictor **313** is further operable for preventing an outgoing call from being made by mobile electronic device **100** while its speed exceeds a speed threshold.

In the embodiment of FIG. **3**, control component **150** further comprises a caller comparator **314** and a call terminator **315**. In embodiments of the present invention, caller comparator **314** is for determining whether an incoming call is from a permitted caller. There are a variety of methods for determining whether an incoming call is coming from a permitted caller in accordance with embodiments of the present invention. In one embodiment, control component **150** can compare the phone number of the incoming call to a stored database (not shown) to determine whether the incoming call is coming from a permitted caller. In embodiments of the present invention, call terminator **315** is for terminating an incoming telephone call if it is determined that the incoming call is not from a permitted originator.

In the embodiment of FIG. **3**, control component **150** further comprises a device verifier **316** for verifying the use of a hands-free device to operate mobile electronic device **100**. As described above with reference to FIG. **2**, in one embodiment if a user is not using a hands-free device (e.g., headset **120**, or automotive Bluetooth® system **130** of FIG. **1**), function controller **303** will restrict the functionality of mobile electronic device **100**. In one embodiment, device verifier **316** does not require the use of a hands-free device unless the speed of mobile electronic device **100** exceeds a speed threshold.

In the embodiment of FIG. **3**, control component **150** further comprises a voice activation verifier **317** for verifying the use of a voice activation system to utilize mobile electronic device **100**. In one embodiment of the present invention, voice activation verifier **317** does not verify the use of a voice activation system unless the speed of mobile electronic device **100** exceeds a speed threshold. In embodiments of the present invention, if a voice activation system is not used when the speed of mobile electronic device **100** exceeds a speed threshold, function controller **303** will restrict the functionality of mobile electronic device **100**.

In the embodiment of FIG. **3**, control component **150** further comprises a shut-down initiator **318** for initiating a shut down sequence of mobile electronic device **100** if its speed exceeds a speed threshold. It is noted that embodiments in accordance with the present invention may comprise more components than discussed above, or may comprise fewer than discussed with reference to FIG. **3**.

In the embodiment of FIG. **3**, control component **150** further comprises an automotive voice activation system verifier **330**. In one embodiment of the present invention, automotive voice activation system verifier **330** is for verifying that an automotive voice activation system is being used to control mobile electronic device **100**. In one embodiment, automotive voice activation system verifier **330** verifies that a Bluetooth® based automotive voice activation system (e.g., automotive Bluetooth® system **130**) is communicatively coupled with mobile electronic device **100**. Additionally, in accordance with embodiments of the present invention, the use of one or more of the above mentioned components is a configurable option when enabling control component **150**. For example, in one embodiment a user can configure control component **150** such that function controller **303** utilizes keypad disabler **312** in response to determining that the speed of mobile electronic device **100** exceeds a speed threshold. In another embodiment, a user can configure control component **150** such that function controller **303** utilizes shut-down initiator **318** in response to determining that the speed of mobile electronic device **100** exceeds a speed threshold. Similarly, control component **150** can be configured such that function controller **303** utilizes audible warning generator **307**, keypad restrictor **308**, key sequence enabler **311**, key sequence verifier **310**, allowed key sequence database **309**, message restrictor **313**, caller comparator **314**, call terminator **315**, device verifier **316**, voice activation verifier **317**, automotive voice activation system verifier **330**, or a combination thereof.

In various embodiments, a control component resident in a mobile electronic device is implemented in response to receiving an indication to limit operating a mobile electronic device in a moving vehicle. As described above, in one embodiment an indication to limit an operation of mobile electronic device **100** is voluntary. For example, a parent configuring mobile electronic device **100** to utilize control component **150** when purchasing it for a child. In another example, a user may elect to utilize control component **150** in order to receive a rate discount from an insurance company. In another embodiment, control component **150** may be utilized by, for example, a cellular telephone manufacturer or service provider in order to unilaterally limit the use of cellular telephones by people operating a vehicle. In another embodiment, control component **150** may be implemented in order to comply with a mandated requirement to limit cell phone use by people operating vehicles.

In one embodiment, a position determining component disposed within the mobile electronic device is used to determine the speed of the mobile electronic device. As discussed above with reference to FIG. **1**, embodiments of the present invention utilize a position determining component which is disposed within a mobile electronic device (e.g., position determining component **112** of FIG. **1**). This is possible in part due to the increasing integration of position determining components within mobile electronic devices such as cellular telephones, PDAs and the like.

In one embodiment, it is determined that the speed of the mobile electronic device exceeds a speed threshold. As described above, in embodiments of the present invention control component **150** compares the current speed of mobile electronic device **100** with speed threshold **390** to determine whether mobile electronic device **100** is being operated in a moving vehicle.

In one embodiment, the functionality of the mobile electronic device is restricted based upon determining that its speed exceeds the speed threshold. As discussed above, in embodiments of the present invention if it is determined that the speed of mobile electronic device **100** exceeds speed threshold **390**, function controller **303** will restrict the functionality of mobile electronic device **100**. In embodiments of the present invention, this may comprise shutting down mobile electronic device **100**, or restricting its operation such that a user will find it inconvenient to continue using mobile electronic device **100**. As a result, the user will be encouraged to pull their vehicle off of the road to continue using mobile electronic device **100**, or to use it later.

Communication System and Wireless Communication Device with Speed Regulated Functionality

FIG. **4** shows a communication system **500** and base station **510** in accordance with embodiments of the present invention. In FIG. **4**, mobile electronic device **100** receives GNSS signals **501** from a plurality of Global Navigation Satellite System (GNSS) satellites **502**. GNSS refers to a number of satellite navigation systems that provide global geo-spatial positioning data which permits electronic devices to determine their geographic position (e.g., latitude, longitude, and altitude) with great precision. Satellite systems included in the GNSS include, but are not limited to: the Global Positioning System (GPS), Galileo, GLONASS, Beidou, and IRNSS navigation systems which are currently, or are soon to be, implemented. In one embodiment, mobile electronic device **100** receives geo-spatial positioning data from a pseudolite which is a technology well known in the art. With reference to the GPS system, each satellite in orbit transmits signals on two frequencies, the L1 frequency and the L2 frequency. Using spread spectrum techniques, a course acquisition (C/A) pseudo-random noise (PRN) code is transmitted on the L1 frequency, and a precise (P) code, which is only available to authorized military and civilian users, is transmitted on the L2 frequency. Each satellite has a unique C/A code which is used to identify a particular satellite and either the C/A code or the P code can be used to determine the distance between a receiver and the satellite. Additionally, each satellite transmits GPS system time, ephemeris data, and almanac data. The receiver detects the time difference between when a signal is received from a satellite and the time the satellite actually broadcasts the signal to determine the distance between the receiver and the satellite. The ephemeris data is used to determine the satellite's position when the signal was broadcast. In embodiments of the present invention, this functionality can be performed by GNSS system **112** of FIG. **1**.

Also shown in FIG. **4** is a cellular base station **510** with which mobile electronic device **100** is communicatively coupled via a wireless network **520**. In the following description, mobile electronic device **100** will be described as a cellular telephone while wireless network **520** and cellular base station **510** are described as a cellular network and a cellular base station respectively. However, it is noted that embodiments of the present invention are not limited to cellular communication networks and/or cellular base stations alone. Instead, the description of a cellular network and a cellular base station are used to clearly describe one embodiment of the present invention. A cellular base station typically utilizes one or more antennas, transceivers, control electronics, a GPS receiver, and signal processors which facilitate cellular communications in the region proximate to the cellular base station. It is noted that while the present description is directed toward cellular telephones and similar electronic devices, embodiments of the present invention are well suited for controlling an operation of other devices and/or machinery as well.

FIG. **5** shows components of cellular base station **510** in accordance with an embodiment of the present invention. In FIG. **5**, cellular base station **510** comprises a wireless communication transceiver **525**, a speed determiner **530**, a communication controller **540**, a GNSS signal acquisition assistance generator **560**, a GNSS receiver **570**, and a speed threshold **595**. It is noted that some components typically found in a cellular base station have been omitted for brevity. Additionally, it is noted that the functionality of separate devices described in FIG. **5** may be integrated in embodiments of the present invention. In the embodiment of FIG. **5**, speed determiner **530** further comprises a comparator **531**, a position determiner **532**, and a relative measurement calculator **533**. Furthermore, in the embodiment of FIG. **5**, communication controller **540** comprises a call inhibitor **541** and a signal generator **542** which will be described in greater detail below.

In one embodiment, cellular base station **510** monitors the speed of mobile electronic device **100** and determines when the speed of mobile electronic device **100** exceeds a pre-determined speed threshold **595**. In embodiments of the present invention, a speed threshold **595** is established which is used by speed determiner **530** to determine if mobile electronic device **100** is being operated while in a moving vehicle. For example, the speed threshold **595** of mobile electronic device **100** can be set at 8 miles per hour. Thus, if it is determined that mobile electronic device **100** has a speed of 9 miles per hour, it may be assumed that it is being operated in a moving vehicle. It is noted that the speed threshold **595** may be set higher or lower than 8 miles per hour in embodiments of the present invention. More generally, the speed threshold **595** set for mobile electronic device **100** will be set higher than the normal walking or running speed of a human in order to be able to establish that mobile electronic device **100** is being operated in a moving vehicle, or at a speed at which it is desirable that the user not be distracted by operating mobile electronic device **100**. Upon determining that the speed of mobile electronic device **100** exceeds the speed threshold **595**, cellular base station **510** can initiate controlling an operation of mobile electronic device **100**. In so doing, cellular base station **510** can prevent a user of mobile electronic device **100** from making, or receiving a telephone call while the speed of mobile electronic device exceeds the speed threshold **595**. In one embodiment, cellular base station **510** can block outgoing calls from mobile electronic device **100** when its speed exceeds the speed threshold **595**. Thus, a user of mobile electronic device **100** will not be able to initiate a telephone call and will not be distracted while operating a vehicle or other device. Additionally, cellular base station **510** may optionally block incoming calls destined for mobile electronic device **100**.

In another embodiment, signal generator **542** of cellular base station **510** generates an offline control signal **590** to mobile electronic device **100** which indicates to control component **150** that the speed of mobile electronic device **100** exceeds the speed threshold **595**. For example, base station **510** may generate control signal **590** which indicates that the speed of mobile electronic device **100** exceeds speed threshold **595**. In response, mobile electronic device may generate an audible signal or display a message on display device **106** indicating that operation of mobile electronic device is not permitted based upon the current speed. In one embodiment, the control signal **590** indicates that the speed of mobile electronic device **100** exceeds speed threshold **595**. In one embodiment, the control signal **590** conveys the speed of mobile electronic device **100**. Control component **150** then determines that the speed of mobile electronic device **100** exceeds speed threshold **390** and controls an operation in response.

For the purposes of the present invention, the term "offline" refers to a message of communication which is not initiated by or intended for a user of mobile electronic device. For example an online signal may comprise a telephone conversation or data that is intended by the customer or consumer. In contrast, an offline signal may comprise a system control signal, a handshaking sequence of signals, remote monitoring signals, system assistance to the remote, and status from the remote to the system where the offline signal is transmitted and received without any requirement that the user is aware of the transmission or reception. In other words, cellular base station **510** generates a message or signal which is received by mobile electronic device **100** without the intervention of the user of mobile electronic device **100**. In response to the offline control signal **590**, control component **150** may restrict the functionality of mobile electronic device **100** as described above with reference to FIG. **3**. In other words, based upon a control signal **590** from cellular base station **510**, mobile electronic device **100** may restrict its operation such that an outgoing, or incoming, cellular telephone call is inhibited while the speed of mobile electronic device **100** is above a speed threshold **595**. In so doing, embodiments of the present invention can prevent a user from operating a cellular telephone while operating a vehicle. Embodiments of the present invention are advantageous in that much of the resource intensive operations can be performed by cellular base station **510**, thus speeding the process of determining the position of mobile electronic device **100**. Additionally, battery power of mobile electronic device **100** can be conserved utilizing embodiments of the present invention.

In one embodiment, cellular base station **510** further comprises a missed communication notice signal transmitter **580** which is configured for generating a missed communication notice signal when it is determined that the speed of mobile electronic device **100** has been below speed threshold **595** for a predetermined time period. In one embodiment, this comprises cellular base station **510** making at least one measurement of the speed of mobile electronic device **100** which is below speed threshold **595**. In one embodiment, a plurality of measurements of the speed of mobile electronic device **100** which are below speed threshold **595** are needed to determine that its speed has been below speed threshold **595** for a sufficient time period. In one embodiment, when the speed of mobile electronic device **100** has been below speed threshold **595** for a sufficient time period, missed communication notice signal transmitter **580** the missed communication notice signal configured to provide notification to mobile electronic device **100** that a communication was missed.

In one embodiment, cellular base station **510** further comprises a text message storage system **581** for storing a text message destined for mobile electronic device **100**. In one embodiment, cellular base station **510** stores text messages destined for mobile electronic device **100** when it has been determined that the speed of mobile electronic device **100** exceeds speed threshold **595**. In one embodiment, cellular base station **510** further comprises a text message transmitter **582** is configured for transmitting a stored text message addressed to mobile electronic device **100** when it has been determined that its speed has been below speed threshold **595** for a predetermined period of time.

FIGS. **6**A, **6**B, **6**C, and **6**D are flowcharts showing sequences of events performed by a communication system in accordance with embodiments of the present invention. As stated above, in one embodiment mobile electronic device **100** comprises a cellular telephone. It is again noted that while the following description is in terms of a cellular telephone network, embodiments of the present are not limited to cellular telephones or cellular networks in general. Typically, when a cellular telephone is first powered on, it is not receiving and/or transmitting an online message. The cellular telephone contacts a cellular base station (e.g., cellular base station **510** of FIG. **5**) and a series of offline (e.g., not initiated by the cellular telephone user) communications are exchanged between the cellular telephone and the cellular base station within range of the cellular telephone. These communications typically exchange the electronic serial number of the cellular telephone, the mobile identification number (e.g., telephone number) associated with the cell phone, and a five-digit system identification code. This information is conveyed via the cellular base station to the mobile telephone exchange which connects the cellular telephone with the PTSD telephone system. Again, these communications take place automatically when the cellular telephone is powered on without any other initiation or intervention by the cellular telephone user.

In operation **601**, cellular base station **510** generates a set of predicted GNSS satellite Dopplers, predicted GNSS code phases, GNSS data bit times, and the current time (e.g., the GNSS clock time) which are then sent to mobile electronic device **100** in an offline message. In contrast to a typical cellular telephone initiation sequence, embodiments of the present invention also send GNSS signal acquisition assistance data to mobile electronic device **100** automatically as well. In the example of FIG. **6**A, this may comprise, but is not limited to, the predicted GNSS Doppler frequency shifts, predicted approximate GNSS code phase offsets, and GNSS satellite data bit times as measured at cellular base station **510** using GNSS receiver **570** as well as the current GNSS clock time. It is noted that embodiments of the present invention may also send additional GNSS data such as carrier frequencies, satellite positions and clock information, ephemeris data, and adjustment data for correcting signal distortion due to ionospheric or tropospheric effects. The carrier frequency assistance may be performed by phase or frequency locking a local oscillator in the mobile electronic device **100** to a carrier or other stable frequency, or a frequency related by M/N to a carrier frequency or other stable frequency, of the communication signal transmitted from the system **500**.

Embodiments of the present invention utilize Assisted-GPS (A-GPS) technology to facilitate the process of determining the position of mobile electronic device **100**. A-GPS is a system in which outside sources provide a GPS receiver with data permitting the receiver to find GPS satellite signals more readily than can be done on a stand alone basis. The data is derived from a GNSS receiver which is proximate to the GNSS receiver which receives the A-GPS data. Because of the proximity of the two GNSS receivers, GNSS signal data such as code phase offsets, Doppler frequency shifts, etc., as well as locally signal errors due to atmospheric or physical conditions should be approximately the same for both receivers. By sending this information to a remote GNSS receiver, the time to fix and track GNSS satellites is greatly reduced for the recipient of this data. The A-GPS system is widely used to comply with the wireless E911 standard which mandated that cellular telephone position information be made available to emergency call dispatchers because it permits a cellular telephone to generate a position fix quicker than if an autonomous position fix was being generated.

Because GPS, and other GNSS navigation systems, rely upon a plurality of satellites which broadcast a unique code, GNSS receivers must determine which codes are being received at a particular location. The receiver must correlate the received C/A code with a stored version and then determine a time delay between when the C/A code was broadcast and when it was received by the receiver. Because the satellite is constantly moving with reference to the receiver, a Doppler shift of the frequency of the C/A code is encountered which can hinder acquisition of the satellite signals because the receiver has to search for the frequency of the C/A code. As a result, it can take minutes for a GPS receiver to create an initial position fix autonomously.

A-GPS was developed to overcome the difficulties in acquiring a signal and to speed the time it takes a receiver to generate a position fix. Due to the proximity of the GPS receiver at the cellular base station to the location of a cellular telephone, the GNSS Dopplers, GNSS code phases, and satellite bit times at the cellular base station (e.g., **510** of FIG. **4**) should closely approximate those of the location of the cellular telephone (e.g., mobile electronic device **100**). Thus, by providing this information to the GPS receiver in the cellular telephone, the GPS receiver can acquire and track satellites better and realize an increase in signal sensitivity.

In operation **602** of FIG. **6**A, GNSS system **112** of mobile electronic device **100** uses the GNSS signal acquisition assistance data to more quickly acquire the satellites within view. As described in FIG. **6**A, this includes, but is not limited to, synchronizing local oscillators to the desired carrier frequencies, tuning with the predicted Dopplers to account for frequency shift due to the relative motion of the satellite and GNSS system **112**, and narrowing the code phase searches based upon the predicted GNSS code phases sent from the cellular base station **510**. GNSS system **112** may further use a GPS time estimate for GPS data bit timing, pre-detection interval timing, generating a clock time tag for a GNSS signal, and for linearizing pseudoranges to satellites. It is noted that in one embodiment, Assisted-GPS data is not required for mobile electronic device **100** to determine its position. However, in one embodiment the use of Assisted-GPS data is beneficial in reducing the time to first fix for mobile electronic device **100**.

In operation **603** of FIG. **6**A, GNSS system **112** acquires satellite signal powers, measures the Doppler shift of the GNSS signal frequency, and determines measured GNSS code phase offsets. Typically, GNSS system **112** utilizes a search algorithm which increments code phases of the received C/A signal to acquire signal power. When a high correlation value between a given phase of the C/A signal stored locally and the received C/A signal is discovered, it indicates that signal power has been found. GNSS system **112** can then measure the Doppler frequency shifts of received signals due to motion of a satellite (e.g., **502** of FIG. **4**) relative to mobile electronic device **100**. For the purposes of the present invention, the terms "GNSS Doppler frequency shift measurement," and "measured GNSS code phase offsets" refer to GNSS Doppler frequency shifts and satellite code phase offsets measured at the location of mobile electronic device **100**. Typically, these measurements are made by mobile electronic device **100** itself although that is not a requirement in embodiments of the present invention.

In operation **604** of FIG. **6**A, mobile electronic device **100** sends GNSS time tags, GNSS Doppler frequency shift measurements, and measured GNSS code phase offsets to the cellular base station **510**. In one embodiment, mobile electronic device **100** may send the satellite code phase offsets to the cellular base station (e.g., **510**) in an offline message. In embodiments of the present invention, the cellular base station **510** uses this data to determine the position and speed of mobile electronic device **100** when it is in motion. In embodiments of the present invention, the sending of A-GPS data to mobile electronic device **100** and the receiving of raw, or processed, data from mobile electronic device **100** is performed periodically based upon a pre-determined time interval. This facilitates monitoring the speed of mobile electronic device **100** for as long as it is powered on.

In operation **605** of FIG. **6**A, the cellular base station **510** uses position determiner **532** to determine the position of mobile electronic device **100** based upon the measured GNSS time tags and measured GNSS code phase offsets sent by mobile electronic device **100**. Embodiments of the present invention utilize methods well known in the art to determine the location of an object based upon GPS code phase and GNSS time tags received at the location of the object. Advantageously, the cellular base station (e.g., **510**) can utilize greater computing resources to determine the location of mobile electronic device **100** than are available to mobile electronic device **100** itself.

In operation **606** of FIG. **6**A, the expected GNSS Doppler frequency shift measurements are determined based upon the position of mobile electronic device **100**. In embodiments of the present invention, the cellular base station determines what the expected Doppler frequency shift should be for received GNSS signals if mobile electronic device **100** were stationary. In other words, the expected Doppler frequency shifts account for the frequency shift incurred due to the motion of the GNSS satellites alone.

In operation **607** of FIG. **6**A, measured satellite Doppler frequency shifts are sent from mobile electronic device **100** to base station **510**. Due to the relative motion of the navigation satellites relative to mobile electronic device **100**, a Doppler frequency shift occurs. This is due in part to the motion of the orbiting navigation satellite and would occur whether mobile electronic device **100** is moving or not. Additionally, some Doppler frequency shift occurs when mobile electronic device **100** is moving. In the embodiment of FIG. **6**A, the Doppler frequency shifts measured by GNSS system **112** of mobile electronic device **100** are sent to base station **510**.

In operation **608** of FIG. **6**A, the speed of mobile electronic device **100** is determined based upon a comparison of the expected GNSS Doppler frequency shifts and the GNSS Doppler frequency shift measurements received from mobile electronic device **100**. In embodiments of the present invention, base station **510** uses speed determiner **530** to determine the speed of GNSS system **112**, and therefore of mobile electronic device **100**.

Satellite line-of-sight (LOS) vectors (e.g., losE, losN, and losU) for the satellite vehicles **502** are calculated between the position of the mobile electronic device **100** and the locations-in-space of the satellites **502** where the locations-in-space are determined from the orbital parameters (e.g., ephemeris or almanac) and GNSS time. The orbital parameters are carried in the data bits of a GNSS message. Each Doppler frequency shift is equivalent by constants to a rate of change in the distance (e.g. range rate) between the satellite **502** and mobile electronic device **100**.

In one embodiment, the speed of mobile electronic device **100** is determined using vector analysis. For example, in one embodiment mobile electronic device **100** measures the Doppler frequency shifts (e.g., measured □fDopplerSV#) in the signals **501** from the satellite vehicles **502**. The measured Dopplers are converted using the SV LOS vectors with vector arithmetic into a measured relative velocity vector. The measured relative velocity vector has 3 dimensions for the velocity of mobile electronic device **100** for the actual motion of mobile electronic device **100** relative to the satellites **502** and a 4th dimension for a frequency error that is common to the four Doppler measurements.

The base station **510** calculates the expected Doppler frequency shifts (e.g., expected □fDopplerSV#) for the signals **501** from the same satellite vehicles **502** with the assumption that mobile electronic device **100** is stationary. (In another embodiment the expected Dopplers are calculated in mobile electronic device **100**). The expected Dopplers are converted using the SV LOS vectors with vector arithmetic into an expected relative velocity vector having the same 3 dimensions for the velocity (but generally different dimensional values) of mobile electronic device **100** relative to the satellites **502** where mobile electronic device **100** is assumed to be stationary, and the fourth dimension for the frequency error in the measurements. The expected relative velocity vector is subtracted from the measurement relative velocity vector to determine the vector velocity of the motion of mobile electronic device **100**. The difference of these two relative vectors can be attributed to the motion of mobile electronic device **100** alone.

In one embodiment, comparator **531** compares the expected GNSS Doppler frequency shifts with the GNSS Doppler frequency shift measurements received from mobile electronic device **100**. A comparison of these values can indicate the motion of mobile electronic device **100** itself independent of the motion of the GNSS satellites. In other words, a difference of the expected GNSS Doppler frequency shift and the GNSS Doppler frequency shift measurement from mobile electronic device **100** is due to motion of mobile electronic device **100**. An example of calculating the speed of mobile electronic device **100** in accordance with one embodiment of the present invention is shown below.

$$\text{Receiver Velocity Vector} - \begin{bmatrix} v_E \\ v_N \\ v_U \\ (\Delta f/f)C \end{bmatrix} =$$

$$\text{Inverse Line-of-sight Vector Matrix} \begin{bmatrix} los_{E,SV1}, los_{N,SV1}, los_{U,SV1}, 1 \\ los_{E,SV2}, los_{N,SV2}, los_{U,SV2}, 1 \\ los_{E,SV3}, los_{N,SV3}, los_{U,SV3}, 1 \\ los_{E,SV4}, los_{N,SV4}, los_{U,SV4}, 1 \end{bmatrix}^{-1} \times$$

$$\text{Measured Range Rate Vector} \begin{bmatrix} \Delta(RR_{SV1}^{measured}) \\ \Delta(RR_{SV2}^{measured}) \\ \Delta(RR_{SV3}^{measured}) \\ \Delta(RR_{SV4}^{measured}) \end{bmatrix}$$

From the measured receiver velocity vector above (e.g., the product of the inverse line-of-sight vector matrix and the measured range rate vector), the expected receiver velocity vector (shown below) is subtracted.

$$\text{Inverse Line-of-sight Vector Matrix} - \begin{bmatrix} los_{E,SV1}, los_{N,SV1}, los_{U,SV1}, 1 \\ los_{E,SV2}, los_{N,SV2}, los_{U,SV2}, 1 \\ los_{E,SV3}, los_{N,SV3}, los_{U,SV3}, 1 \\ los_{E,SV4}, los_{N,SV4}, los_{U,SV4}, 1 \end{bmatrix}^{-1} \times$$

$$\text{Expected Range Rate Vector} \begin{bmatrix} (RR_{SV1}^{expected}) \\ (RR_{SV2}^{expected}) \\ (RR_{SV3}^{expected}) \\ (RR_{SV4}^{expected}) \end{bmatrix}$$

It is noted that the ones are added to the inverse line-of-sight vector matrices to create a 4×4 matrix. Matrix arithmetic is then used to resolve the 4D velocity vector (V_E, V_N, V_U, and (□f/f)/C). In the above example, the speed of mobile electronic device **100**=$\sqrt{(V_E^2, V_N^2, V_U^2)}$, or approximately $\sqrt{(V_E^2, V_N^2)}$ as the velocity up (V_U) will typically not contribute greatly to the determination of the speed of GNSS system **112**. For example, an error of less than 0.5% occurs at a 6% grade using $\sqrt{(V_E^2, V_N^2)}$ as the velocity of mobile electronic device **100**.

An example of calculating the speed of mobile electronic device **100** using 3 SVs in accordance with one embodiment of the present invention is shown below.

$$\begin{bmatrix} v_E \\ v_N \\ (\Delta f/f)C \end{bmatrix} = \begin{bmatrix} los_{E,SV1}, los_{N,SV1}, 1 \\ los_{E,SV2}, los_{N,SV2}, 1 \\ los_{E,SV3}, los_{N,SV3}, 1 \end{bmatrix}^{-1} \times \begin{bmatrix} \Delta(RR_{SV1}^{measured}) \\ \Delta(RR_{SV2}^{measured}) \\ \Delta(RR_{SV3}^{measured}) \end{bmatrix}$$

From the receiver velocity vector above, the expected receiver velocity vector (shown below) is subtracted.

$$\text{Inverse Line-of-sight Vector Matrix} \begin{bmatrix} los_{E,SV1}, los_{N,SV1}, 1 \\ los_{E,SV2}, los_{N,SV2}, 1 \\ los_{E,SV3}, los_{N,SV3}, 1 \end{bmatrix}^{-1} \times$$

$$\text{Expected Range Rate Vector} \begin{bmatrix} (RR_{SV1}^{expected}) \\ (RR_{SV2}^{expected}) \\ (RR_{SV3}^{expected}) \end{bmatrix}$$

In the above example, the 2-dimensional speed of mobile electronic device **100**=$\sqrt{(V_E^2, V_N^2,)}$. Again, an error of less than 0.5% occurs at a 6% grade using $\sqrt{(V_E^2, V_N^2)}$ as the velocity of mobile electronic device **100**. It is noted that the operations described above may also be performed by mobile electronic device **100** itself using speed determiner **160**.

In one embodiment, the use of vectors to determine the speed of mobile electronic device **100** is not a requirement. Instead, a range rate which is a scalar value proportional to the Doppler frequency shift, is used to determine the speed of mobile electronic device **100**. In other words, the GNSS Doppler frequency shift measurement from mobile electronic device **100** is converted to a measured range rate using some constant factor(s). In one embodiment, the calculation of a plurality of measured range rates corresponding to a plurality of GNSS Doppler frequency shift measurements, and calculating a plurality of expected range rates between mobile electronic device **100** and a plurality of GNSS satellites, is performed by relative measurement calculator **533**.

As an example, in one embodiment, an SV line-of-sight vector (LOS) (e.g., los_E, los_N, and los_U) in a east/north/up coordinate system is calculated between a location-in-space of a navigation satellite (e.g., **502** of FIG. **4**) and the approximate position of mobile electronic device **100**. Component directions are E for east, N for north, and U for up. It is noted that other component directions known in the arts may be used including, but not limited to, an X, Y, Z coordinate system, an earth-centered coordinate system, etc. The LOS vector is also called the unit vector or directional cosine.

An expected range rate ($RR^{expected}_{SV\#}$) is calculated by taking the dot product of the LOS and velocity-in-space of the SV. The expected range rate is a scalar value. The term "relative" encompasses the relative motion between the SV (e.g., **502** of FIG. **4**) and mobile electronic device **100** as well as relative according to a constant factor. For example, the expected range rate is relative by a constant factor to an expected Doppler frequency shift at the geographic position of mobile electronic device **100**. In one embodiment, the constant factor may comprise the speed of light (C), meters per second, or another value.

In one embodiment, comparator **531** is configured to compare the measured range rates with the expected range rates to determine the speed of mobile electronic device **100**. A range rate difference is calculated as the difference between the measured range rate ($RR^{measured}_{SV\#}$) at the position of mobile electronic device **100** and the expected range rate ($RR^{expected}_{SV\#}$) if mobile electronic device **100** were stationary at that position (e.g., $RR^{measured}_{SV\#}$_$RR^{expected}_{SV\#}$). The difference between these values is attributable to the motion of mobile electronic device **100**.

In one embodiment, the 3-dimensional velocity (e.g., E, N, and U) of mobile electronic device **100** is calculated as well as the GPS receiver clock error ($\Delta f/f$) by resolving 4 unknowns (e.g., V_E, V_N, V_U, and ($\Delta f/f$)/C) with 4 equations for 4 SVs. It is noted that the range rate can be carried out proportionally using Dopplers in place of range rates, or with the constant C, or with several placements of other constant factors. An example of calculating the speed of mobile electronic device **100** in accordance with one embodiment of the present invention is shown below.

$$\text{Receiver Velocity Vector}\begin{bmatrix} v_E \\ v_N \\ v_U \\ (\Delta f/f)C \end{bmatrix} =$$

$$\text{Inverse Line-of-sight Vector Matrix}\begin{bmatrix} los_{E,SV1}, los_{N,SV1}, los_{U,SV1}, 1 \\ los_{E,SV2}, los_{N,SV2}, los_{U,SV2}, 1 \\ los_{E,SV3}, los_{N,SV3}, los_{U,SV3}, 1 \\ los_{E,SV4}, los_{N,SV4}, los_{U,SV4}, 1 \end{bmatrix}^{-1} \times$$

$$\text{Relative Range Rate Vector}\begin{bmatrix} \Delta\left(RR_{SV1}^{measured} - RR_{SV1}^{expected}\right) \\ \Delta\left(RR_{SV2}^{measured} - RR_{SV2}^{expected}\right) \\ \Delta\left(RR_{SV3}^{measured} - RR_{SV3}^{expected}\right) \\ \Delta\left(RR_{SV4}^{measured} - RR_{SV4}^{expected}\right) \end{bmatrix}$$

It is noted that the ones are added to the inverse line-of-sight vector matrix to create a 4×4 matrix. Matrix arithmetic is then used to resolve the 4D velocity vector (V_E, V_N, V_U, and ($\Delta f/f$)/C). In the above example, the speed of mobile electronic device **100**=$\sqrt{(V_E^2, V_N^2, V_U^2)}$, or approximately $\sqrt{(V_E^2, V_N^2)}$ as the velocity up (V_U) will typically not contribute greatly to the determination of the speed of GNSS system **112**. For example, an error of less than 0.5% occurs at a 6% grade using $\sqrt{(V_E^2, V_N^2)}$ as the velocity of mobile electronic device **100**.

An example of calculating the speed of mobile electronic device **100** using 3 SVs in accordance with one embodiment of the present invention is shown below.

$$\text{Receiver Velocity Vector}\begin{bmatrix} v_E \\ v_N \\ (\Delta f/f)C \end{bmatrix} =$$

$$\text{Inverse Line-of-sight Vector Matrix}\begin{bmatrix} los_{E,SV1}, los_{N,SV1}, 1 \\ los_{E,SV2}, los_{N,SV2}, 1 \\ los_{E,SV3}, los_{N,SV3}, 1 \end{bmatrix}^{-1} \times$$

$$\text{Relative Range Rate Vector}\begin{bmatrix} \Delta\left(RR_{SV1}^{measured} - RR_{SV1}^{expected}\right) \\ \Delta\left(RR_{SV2}^{measured} - RR_{SV2}^{expected}\right) \\ \Delta\left(RR_{SV3}^{measured} - RR_{SV3}^{expected}\right) \end{bmatrix}$$

In the above example, the 2-dimensional speed of mobile electronic device **100**=$\sqrt{(V_E^2, V_N^2,)}$. Again, an error of less than 0.5% occurs at a 6% grade using $\sqrt{(V_E^2, V_N^2)}$ as the velocity of mobile electronic device **100**. It is noted that the operations described above may also be performed by mobile electronic device **100** itself using speed determiner **160**.

In operation **610** of FIG. **6**A, an operation of mobile electronic device **100** is controlled when its speed is determined to exceed a pre-determined speed threshold **595**. More specifically, in the embodiment of FIG. **6**A call inhibitor **541** prevents outgoing calls originating from mobile electronic device **100** in operation **610**. Call inhibitor **541** may additionally block incoming calls destined for mobile electronic device **100** in response to this signal. In one embodiment, when the speed of mobile electronic device **100** exceeds a speed threshold **595**, an incoming call destined for mobile electronic device **100** is automatically routed to a voice mail account of mobile electronic device **100**. Alternatively, a text message destined for mobile electronic device **100** is stored at cellular base station **510**. In one embodiment of the present invention, signal generator **542** is used to generate an offline control signal **590** to mobile electronic device **100** indicating that it is exceeding the speed threshold **595**. This may be in addition to the operation of call inhibitor **541**, or may be in place of utilizing call inhibitor **541**.

It is noted that the speed of mobile electronic device **100** can be monitored as long as it is powered on and full functionality can be restored when it is determined that the speed of mobile electronic device **100** is below the speed threshold **590**. In one embodiment, the speed of mobile electronic device **100** must stay below the speed threshold **590** for a pre-determined period of time before incoming and/or outgoing calls are again permitted. This prevents a user from temporarily slowing down in order to enable the use of mobile electronic device **100**. In one embodiment, this may comprise determining at least once that the speed of mobile electronic device **100** is below the speed threshold **590**. Typically, a plurality of determinations of the speed of mobile electronic device **100** is made within a pre-determined time period. If the speed of mobile electronic device **100** is below the speed threshold **590** in each of these determinations, it is assumed that mobile electronic device **100** can be operated in a safe manner.

In embodiments of the present invention, when the speed of mobile electronic device **100** is below the speed threshold **590** for a pre-determined period, the incoming calls and/or text messages destined for mobile electronic device **100** which were automatically routed to the voice mail account are automatically forwarded to mobile electronic device **100**. In one embodiment, a missed communication notice signal is sent from cellular base station **510** to mobile electronic device **100**. This notifies the operator of mobile electronic device **100** that voice messages and/or text messages are being stored for them.

FIG. **6**B shows an alternative sequence of events in accordance with embodiments of the present invention. In FIG. **6**B, the events described above with reference to FIG. **6**A which are generally followed in FIG. **6**B will be omitted for brevity. In operation **611** of FIG. **6**B, rather than inhibiting a transmission of a communication to or from mobile electronic device **100**, base station **510** generates an offline control signal (e.g., **590** of FIG. **4**) to mobile electronic device **100**. In response to receiving control signal **590**, control component **150** controls an operation of mobile electronic device **100**. Additionally, the speed of mobile electronic device **100** can be monitored as long as it is powered on and full functionality can be restored when it is determined that the speed of mobile electronic device **100** is below the speed threshold **595**. In one embodiment, the speed of mobile electronic device **100** must stay below the speed threshold **595** for a pre-determined period of time before incoming and/or outgoing calls are again permitted. In one embodiment, when the speed of mobile electronic device **100** is below speed threshold **595** for a pre-determined time interval, signal generator **542** can generate a second control signal which indicates to control component **150** that full functionality of mobile electronic device **100** can be restored.

FIG. **6**C shows an alternative sequence of events in accordance with embodiments of the present invention. In FIG. **6**C, the events described above with reference to FIG. **6**A which are generally followed in FIG. **6**C will be omitted for brevity. In operation **613** of FIG. **6**C, upon determining that the speed of mobile electronic device exceeds speed threshold **595**, base station **510** generates control signal **590** which conveys the speed of mobile electronic device **100**. In operation **614** of FIG. **6**C, mobile electronic device **100** receives this control signal and control component **150** compares the speed conveyed in control signal **590** with speed threshold **390** using speed comparator **302**. In operation **615** of FIG. **6**C, speed comparator **302** determines that the speed of mobile electronic device **100** exceeds speed threshold **390**. In one embodiment, when speed comparator **302** determines that the speed of mobile electronic device **100** exceeds speed threshold **390**, it generates a control signal to function controller **303**. In response to receiving the control signal, function controller **303** controls an operation of mobile electronic device **100** in operation **616** as described above.

FIG. **6**D shows an alternative sequence of events in accordance with embodiments of the present invention. In FIG. **6**D, the events described above with reference to FIG. **6**A which are generally followed in FIG. **6**D will be omitted for brevity. In FIG. **6**D, after acquiring satellite signal powers, determining measured satellite Dopplers, and determining measured satellite code phases, mobile electronic device **100** determines its position in operation **617**. In the embodiment of FIG. **6**D, position determiner **162** determines the position of mobile electronic device **100** based upon the measured GNSS time tags and measured GNSS code phase offsets received by GNSS system **112**.

Embodiments of the present invention utilize methods well known in the art to determine the location of an object based upon GPS code phase and GNSS time tags received at the location of the object.

In operation **618** of FIG. **6**D, the expected GNSS Doppler frequency shift measurements are determined based upon the position of mobile electronic device **100**. In embodiments of the present invention, mobile electronic device **100** determines what the expected Doppler frequency shift should be for received GNSS signals if mobile electronic device **100** were stationary.

In operation **619** of FIG. **6**D, mobile electronic device **100** determines its speed by comparing expected satellite Dopplers with measured satellite Dopplers. In one embodiment, speed determiner **160** determines the speed of mobile electronic device **100** as described above with reference to operation **608** of FIG. **6**A.

In operation **620** of FIG. **6**D, it is determined that the speed of mobile electronic device **100** exceeds a speed threshold. In one embodiment, speed determiner **160** generates a signal which conveys the speed of mobile electronic device **100** to control component **150**. Speed comparator **302** then compares that speed with speed threshold **390**. When speed comparator **302** determines that the speed of mobile electronic device **100** exceeds speed threshold **390**, speed comparator generates a control signal to function controller **303**.

In operation **621** of FIG. **6**D, an operation of mobile electronic device **100** is controlled in response to determining that its speed exceeds speed threshold **390**. As described above, control component **150** is configured to control an operation of mobile electronic device **100** as described above with reference to FIG. **3**.

FIG. **7** is a flowchart **700** of a method for limiting the functionality of an electronic device in accordance with embodiments of the present invention. In operation **710** of FIG. **7**, a wireless signal, comprising at least one GNSS Doppler frequency shift measurement corresponding to a GNSS signal received at a mobile electronic device, is received at a base station. As described above with reference to FIGS. **6**A and **6**B, a cellular base station (e.g., **510**) receives measured GNSS Doppler frequency shift measurements which are measured at the location of mobile electronic device **100**. In one embodiment, the of GNSS Doppler frequency shift measurement is performed by mobile electronic device **100** itself. In one embodiment, the cellular base station (e.g., **510**) uses the measured code phase offsets to determine the position of mobile electronic device **100**. In another embodiment, cellular base station **510** may receive the position of mobile electronic device **100** rather than derive the position based upon the measured GNSS satellite code phase offsets.

In operation **720** of FIG. **7**, the speed of the mobile electronic device is determined based at least in part on the GNSS Doppler frequency shift measurement. As described above, in one embodiment cellular base station (e.g., **510**) determines the speed of mobile electronic device **100** based upon a comparison of the GNSS Doppler frequency shift measurements received from mobile electronic device **100** and the expected GNSS Doppler frequency shifts (e.g., received from GNSS receiver **570**). As described above with reference to operation **609** of FIG. **6**A, the speed of mobile electronic device may be determined based upon a vector analysis of at least one Doppler frequency shift, or of range rates which are relative by a constant factor to an expected Doppler frequency shift at the geographic position of mobile electronic device **100**. In one embodiment, cellular base station **510** additionally uses an indication of the geographic position of mobile electronic device **100** in making a determination of the speed of mobile electronic device **100**. In one embodiment, this is based upon cellular base station **510** receiving at least one measured GNSS code phase offset from mobile electronic device **100**.

As described above, the expected GNSS Doppler frequency shift is based upon the relative motion of a GNSS satellite and a fixed location. However, when mobile electronic device **100** is moving, the Doppler frequency shift will be different from the expected Doppler frequency shift. The difference between the GNSS Doppler frequency shift measurements and the expected GNSS Doppler frequency shifts is due to the motion of mobile electronic device **100**. Thus, in one embodiment base station **510** determines the difference between the expected GNSS Doppler frequency shifts and the GNSS Doppler frequency shift measurements received from mobile electronic device to determine the speed of mobile electronic device **100**.

In operation **730** of FIG. **7**, an operation associated with the mobile electronic device is controlled from the base station when the speed of the remote device exceeds a speed threshold. As described above, cellular base station **510** can block incoming and/or outgoing calls for mobile electronic device **100** upon determining that the speed of mobile electronic device **100** exceeds a speed threshold **595**. Alternatively, cellular base station may generate a control signal **590** to mobile electronic device **100** which indicates that the speed of mobile electronic device **100** exceeds a speed threshold **595**. Upon receiving the control signal **590** from cellular base station

510, control component 150 can control the functionality of mobile electronic device 100 as described above with reference to FIG. 3.

FIG. 8 is a flowchart of a method 800 for limiting the functionality of a mobile electronic device in accordance with embodiments of the present invention. In operation 810 of FIG. 8, a GNSS receiver is used to determine a GNSS Doppler frequency shift measurement corresponding to a GNSS signal. In one embodiment, mobile electronic device 100 determines a GNSS Doppler frequency shift measurement which is due to the relative motion of mobile electronic device 100 and a GNSS satellite which is generating a GNSS navigation signal.

In operation 820 of FIG. 8, an operation of the mobile electronic device is controlled in response to a control signal which is generated when the GNSS Doppler frequency shift measurement is used to determine that a speed of the mobile electronic device exceeds a speed threshold. In one embodiment, the transmission of measured GNSS code phase offsets and/or GNSS Doppler frequency shift measurements are typically sent from mobile electronic device 100 in one or more offline transmissions. The GNSS Doppler frequency shift measurements can be used by cellular base station 510 to determine the speed of mobile electronic device 100 by comparing them with the expected GNSS Doppler frequency shifts which are measured by, for example, GNSS receiver 570. The measured GNSS code phase offsets can be used by cellular base station 510 to determine the position of mobile electronic device 100. It is again noted that the position of mobile electronic device 100 may be determined by GNSS system 112 and sent to cellular base station 510.

In one embodiment, an offline control signal 590 is received at mobile electronic device 100 when the base station 510 determines that the speed of the mobile electronic device 100 exceeds a speed threshold. As described above, cellular base station 510 uses the GNSS Doppler frequency shift measurement received from mobile electronic device 100 to determine the speed of mobile electronic device 100. In one embodiment, in response to determining that the speed of mobile electronic device 100 exceeds a speed threshold 595, cellular base station 510 generates a control signal 590 to mobile electronic device 100. In one embodiment, the control signal 590 indicates to mobile electronic device 100 that it is exceeding the speed threshold 595. In another embodiment, control signal 590 conveys the speed of mobile electronic device. Speed comparator 302 of mobile electronic device compares that speed with speed threshold 390. When speed comparator 302 determines that the speed of mobile electronic device exceeds speed threshold 390, it generates a control signal. In response to the control signal, function controller 303 controls an operation of mobile electronic device 100.

In one embodiment, a control component 150 disposed within the wireless communication device is utilized to automatically control an operation of the wireless communication device in response to the offline control signal 590. As described above, control component 150 is disposed within volatile memory 103 in one embodiment. In one embodiment, control component 150 is configured to automatically control an operation of mobile electronic device 100 in response to an offline control signal 590 generated by cellular base station 510. As described above with reference to FIG. 3, control component 150 can prevent the exchange of messages between mobile electronic device 100 and other locations such as cellular base station 510. In one embodiment, control component 150 is configured to require the implementation of safety measures when operating mobile electronic device 100 such as the use of a hands free headset, the use of a voice activation system, etc. In another embodiment, speed determiner 160 of mobile electronic device 100 determines the speed of mobile electronic device. Speed comparator 302 generates a control signal when the speed of mobile electronic device 100 exceeds speed threshold 390. In response, function controller 303 controls an operation of mobile electronic device 100.

FIG. 9 is a block diagram of an exemplary computer system 900 upon which embodiments of the present invention may be implemented. With reference to FIG. 9, portions of the present invention are comprised of computer-readable and computer-executable instructions that reside, for example, in computer system 900 which is used as a part of a general purpose computer network (not shown). It is appreciated that computer system 900 of FIG. 9 is exemplary only and that the present invention can operate within a number of different computer systems including general-purpose computer systems, embedded computer systems, laptop computer systems, hand-held computer systems, and stand-alone computer systems. In embodiments of the present invention, cellular base station 510 may implement various components such as speed determiner 530, comparator 531, communication controller 540, call inhibitor 541, signal generator 542, and GNSS signal acquisition assistance generator 560 using computer system 900.

In the present embodiment, computer system 900 includes an address/data bus 901 for conveying digital information between the various components, a central processor unit (CPU) 902 for processing the digital information and instructions, a volatile main memory 903 comprised of volatile random access memory (RAM) for storing the digital information and instructions, and a non-volatile read only memory (ROM) 904 for storing information and instructions of a more permanent nature. In addition, computer system 900 may also include a data storage device 905 (e.g., a magnetic, optical, floppy, or tape drive or the like) for storing vast amounts of data. It should be noted that the software program for limiting the functionality of an electronic device of the present invention can be stored either in volatile memory 903, data storage device 905, or in an external storage device (not shown).

Devices which are optionally coupled to computer system 900 include a display device 906 for displaying information to a computer user, an alpha-numeric input device 907 (e.g., a keyboard), and a cursor control device 908 (e.g., mouse, trackball, light pen, etc.) for inputting data, selections, updates, etc. Computer system 900 can also include a mechanism for emitting an audible signal (not shown).

Returning still to FIG. 9, optional display device 906 of FIG. 9 may be a liquid crystal device, cathode ray tube, or other display device suitable for creating graphic images and alpha-numeric characters recognizable to a user. Optional cursor control device 908 allows the computer user to dynamically signal the two dimensional movement of a visible symbol (cursor) on a display screen of display device 906. Many implementations of cursor control device 908 are known in the art including a trackball, mouse, touch pad, joystick, or special keys on alpha-numeric input 907 capable of signaling movement of a given direction or manner displacement. Alternatively, it will be appreciated that a cursor can be directed and/or activated via input from alpha-numeric input 907 using special keys and key sequence commands. Alternatively, the cursor may be directed and/or activated via input from a number of specially adapted cursor directing devices.

Furthermore, computer system 900 can include an input/output (I/O) signal unit (e.g., interface) 909 for interfacing with a peripheral device **910** (e.g., a computer network, modem, mass storage device, etc.). Accordingly, computer system **900** may be coupled in a network, such as a client/server environment, whereby a number of clients (e.g., personal computers, workstations, portable computers, minicomputers, terminals, etc.) are used to run processes for performing desired tasks. In particular, computer system **900** can be coupled in a system for limiting the functionality of an electronic device.

EXAMPLE GNSS RECEIVER

With reference now to FIG. **10**, a block diagram is shown of an embodiment of an example satellite navigation receiver which may be used in accordance an embodiment described herein. In particular, FIG. **10** illustrates a block diagram of a GNSS receiver (e.g., **113** of FIG. **1** and/or **570** of FIG. **5**) in the form of a general purpose GPS receiver capable of demodulation of the L**1** and/or L**2** signal(s) received from one or more GPS satellites. For the purposes of the following discussion, the demodulation of L**1** and/or L**2** signals is discussed. It is noted that demodulation of the L**2** signal(s) is typically performed by "high precision" GNSS receivers such as those used in the military and some civilian applications. Typically, the "consumer" grade GNSS receivers do not access the L**2** signal(s). Embodiments of the present technology may be utilized by GNSS receivers which access the L**1** signals alone, or in combination with the L**2** signal(s). A more detailed discussion of the function of a receiver such as GPS receiver **113** can be found in U.S. Pat. No. 5,621,426. U.S. Pat. No. 5,621,426, by Gary R. Lennen, is titled "Optimized processing of signals for enhanced cross-correlation in a satellite positioning system receiver," and includes a GPS receiver very similar to GNSS receiver **113** of FIG. **10**.

In FIG. **10**, received L**1** and L**2** signal is generated by at least one GPS satellite. Each GPS satellite generates different signal L**1** and L**2** signals and they are processed by different digital channel processors **1052** which operate in the same way as one another. FIG. **10** shows GPS signals (L**1**=1575.42 MHz, L**2**=1227.60 MHz) entering GPS receiver **113** through a dual frequency antenna **114**. Master oscillator **1048** provides the reference oscillator which drives all other clocks in the system. Frequency synthesizer **1038** takes the output of master oscillator **1048** and generates important clock and local oscillator frequencies used throughout the system. For example, in one embodiment frequency synthesizer **1038** generates several timing signals such as a 1st LO**1** (local oscillator) signal 1400 MHz, a 2nd LO**2** signal 175 MHz, a (sampling clock) SCLK signal 25 MHz, and a MSEC (millisecond) signal used by the system as a measurement of local reference time.

A filter/LNA (Low Noise Amplifier) **1034** performs filtering and low noise amplification of both L**1** and L**2** signals. The noise figure of GPS receiver **113** is dictated by the performance of the filter/LNA combination. The downconverter **1036** mixes both L**1** and L**2** signals in frequency down to approximately 175 MHz and outputs the analogue L**1** and L**2** signals into an IF (intermediate frequency) processor **30**. IF processor **1050** takes the analog L**1** and L**2** signals at approximately 175 MHz and converts them into digitally sampled L**1** and L**2** in-phase (L**1** I and L**2** I) and quadrature signals (L**1** Q and L**2** Q) at carrier frequencies 420 KHz for L**1** and at 2.6 MHz for L**2** signals respectively.

At least one digital channel processor **1052** inputs the digitally sampled L**1** and L**2** in-phase and quadrature signals. All digital channel processors **1052** are typically are identical by design and typically operate on identical input samples. Each digital channel processor **1052** is designed to digitally track the L**1** and L**2** signals produced by one satellite by tracking code and carrier signals and to form code and carrier phase measurements in conjunction with the microprocessor system **1054**. One digital channel processor **1052** is capable of tracking one satellite in both L**1** and L**2** channels. Microprocessor system **1054** is a general purpose computing device which facilitates tracking and measurements processes, providing pseudorange and carrier phase measurements for a navigation processor **1058**. In one embodiment, microprocessor system **1054** provides signals to control the operation of one or more digital channel processors **1052**. Navigation processor **1058** performs the higher level function of combining measurements in such a way as to produce position, velocity and time information for determining a position. Storage **1060** is coupled with navigation processor **1058** and microprocessor system **1054**. It is appreciated that storage **1060** may comprise a volatile or non-volatile storage such as a RAM or ROM, or some other computer readable memory device or media. It is noted that microprocessor system **1054**, navigation processor **1058** and/or storage **1060** may reside outside of receiver **113** in an embodiment of the present invention. In other words, the functions performed by microprocessor system **1054** and/or navigation processor **1058** may be performed by processor **101** of FIG. **1**.

The preferred embodiment of the present invention, method and communication system for limiting the functionality of an electronic device, is thus described. While the present invention has been described in particular embodiments, it should be appreciated that the present invention should not be construed as limited by such embodiments, but rather construed according to the following claims.

What is claimed is:

1. A mobile electronic device comprising:

a Global Navigation Satellite System (GNSS) receiver configured to determine a GNSS Doppler frequency shift measurement corresponding to a GNSS signal; and

a control component configured to control an operation of said mobile electronic device in response to a control signal received from a system comprising a speed determiner configured to use said GNSS Doppler frequency shift measurement to determine a speed of said mobile electronic device wherein said speed determiner is further configured to use a geographical position corresponding to said mobile electronic device and an orbital parameter for a GNSS satellite to determine an expected value proportional to an expected range rate between said mobile electronic device and a GNSS satellite and configured to use said expected value with said GNSS Doppler frequency shift measurement to determine said speed and wherein said control signal is generated when said GNSS Doppler frequency shift measurement is used to determine that said speed of said mobile electronic device exceeds a speed threshold.

2. The mobile electronic device of claim **1** further comprising:

a communication transceiver configured to automatically transmit to a station an offline GNSS data signal comprising said GNSS Doppler frequency shift measurement and a time tag, and to automatically receive from said station an offline signal which conveys said control signal when said station uses said GNSS Doppler frequency shift measurement to determine that said speed of said mobile electronic device exceeds said speed threshold.

3. The mobile electronic device of claim **2** wherein said communication transceiver is configured to receive one or more offline wireless signals comprising a predicted Doppler frequency shift, a predicted GNSS code phase offset, a GNSS data bit time prediction, and a GNSS clock time estimate for use by the GNSS receiver for acquiring said GNSS signal.

4. The mobile electronic device of claim **3** wherein said GNSS receiver is configured to use said predicted Doppler frequency shift, said predicted GNSS code phase offset, said GNSS data bit time prediction, and said GNSS clock time estimate for tuning to a carrier frequency, decreasing a time for making said measurement of said Doppler frequency shift, narrowing a range of GNSS code phase offsets for making a GNSS code phase offset determination and generating a GNSS clock time tag for said GNSS signal.

5. The mobile electronic device of claim **1** wherein said system is configured to receive at least one GNSS code phase offset determination for said GNSS signal received at said mobile electronic device and wherein said speed determiner is configured to determine said geographic position of said mobile electronic device based at least in part on said GNSS code phase offset determination.

6. The mobile electronic device of claim **1** further comprising:

a communication transceiver configured to receive an offline wireless signal having said speed; and:

a speed comparator configured to determine when said speed exceeds said speed threshold.

7. The mobile electronic device of claim **1** wherein said speed determiner further comprises:

a relative measurement calculator configured to calculate a plurality of measured range rates corresponding to a plurality of said GNSS Doppler frequency shift measurements and calculating a plurality of expected range rates between said mobile electronic device and a plurality of GNSS satellites; and

a comparator configured to compare said measured range rates with said expected range rates to determine said speed.

8. The mobile electronic device of claim **1** wherein said control component is configured to initiate an action in response to said control signal and wherein said action is selected from the group consisting of: generating an audible notification by said mobile electronic device when a user input device in said mobile electronic device is operated, restricting an operation of a user input device of said mobile electronic device, requiring the use of a hands-free operation device to operate said mobile electronic device, and requiring the use of a voice activation system to operate said mobile electronic device.

9. The mobile electronic device of claim **1** further comprising:

a communication transceiver configured to receive one or more offline wireless signals comprising a predicted Doppler frequency shift, a predicted GNSS code phase offset, a GNSS data bit time prediction, and a GNSS clock time estimate and wherein said GNSS receiver is configured to use said predicted Doppler frequency shift, said predicted GNSS code phase offset, said GNSS data bit time prediction, and said GNSS clock time estimate for tuning to a carrier frequency, decreasing a time for making said measurement of said Doppler frequency shift, narrowing a range of GNSS code phase offsets for making a GNSS code phase offset determination and generating a GNSS clock time tag for said GNSS signal, said communication transceiver further configured to transmit to a station an offline GNSS data signal comprising said GNSS Doppler frequency shift measurement, said GNSS code phase offset determination, and a time tag and to receive from said station an offline signal which conveys said control signal when said station uses said GNSS Doppler frequency shift measurement to determine that said speed of said mobile electronic device exceeds said speed threshold; and

and wherein said station determines said geographic position of said mobile electronic device based at least in part on said GNSS code phase offset determination and utilizes a speed determiner configured to use an orbital parameter for a GNSS satellite to determine a relative expected value proportional to a relative expected range rate between said mobile electronic device and said GNSS satellite and is further configured to use said relative expected value with said GNSS Doppler frequency shift measurement to determine said speed and to generate said control signal in response to determining that said speed of said mobile electronic device exceeds said speed threshold.

10. The mobile electronic device of claim **9** wherein said speed determiner further comprises:

a relative measurement calculator configured to calculate a plurality of measured range rates corresponding to a plurality of said GNSS Doppler frequency shift measurements and calculating a plurality of expected range rates between said mobile electronic device and a plurality of GNSS satellites; and

a comparator configured to compare said measured range rates with said expected range rates to determine said speed.

11. The mobile electronic device of claim **1** wherein said control signal conveys said speed from a base station to said mobile electronic device and wherein said control component is configured to control an operation of said mobile electronic device in response to said control signal.

12. The mobile electronic device of claim **1** further comprising:

a speed determiner configured to use said GNSS Doppler frequency shift measurement to determine that a speed of said mobile electronic device exceeds said speed threshold and to generate said control signal in response to said determining.

13. The mobile electronic device of claim **12** further comprising:

a communication transceiver configured to receive one or more offline wireless signals comprising a predicted Doppler frequency shift, a predicted GNSS code phase offset, a GNSS data bit time prediction, and a GNSS clock time estimate.

14. The mobile electronic device of claim **12** wherein said GNSS receiver is configured to use said predicted Doppler frequency shift, said predicted GNSS code phase offset, said GNSS data bit time prediction, and said GNSS clock time estimate for tuning to a carrier frequency, decreasing a time for making said measurement of said Doppler frequency shift, narrowing a range of GNSS code phase offsets for making a GNSS code phase offset determination and generating a GNSS clock time tag for said GNSS signal.

15. The mobile electronic device of claim **12** wherein said speed determiner is further configured to use a geographical position corresponding to said mobile electronic device and an orbital parameter for a GNSS satellite to determine an expected value proportional to a expected range rate for said GNSS satellite and configured to use said expected value with said GNSS Doppler frequency shift measurement to determine said speed.

16. The mobile electronic device of claim **15** wherein said speed determiner further comprises:

a relative measurement calculator configured to calculate a plurality of measured range rates corresponding to a plurality of said GNSS Doppler frequency shift measurements and calculating a plurality of expected range rates between said mobile electronic device and a plurality of GNSS satellites; and

a comparator configured to compare said measured range rates with said expected range rates to determine said speed.

17. A method for limiting the functionality of a mobile electronic device, said method comprising:

using a Global Navigation Satellite System (GNSS) receiver to determine a GNSS Doppler frequency shift measurement corresponding to a GNSS signal; and

controlling an operation of said mobile electronic device in response to receiving a control signal from a system comprising a speed determiner configured to use said GNSS Doppler frequency shift measurement to determine a speed of said mobile electronic device and to use a geographical position corresponding to said mobile electronic device and an orbital parameter for a GNSS satellite to determine an expected value proportional to an expected range rate between said mobile electronic device and a GNSS satellite and to use said expected value with said GNSS Doppler frequency shift measurement to determine said speed and wherein said control signal is generated when said GNSS Doppler frequency shift measurement is used to determine that said speed of said mobile electronic device exceeds a speed threshold.

18. The method as recited in claim **17** further comprising:

transmitting to a station an offline GNSS data signal comprising said GNSS Doppler frequency shift measurement and a time tag; and

automatically receiving an offline signal from said station which conveys said control signal when said station uses said GNSS Doppler frequency shift measurement to determine that said speed of said mobile electronic device exceeds said speed threshold.

19. The method as recited in claim **18** further comprising:

receiving one or more offline wireless signals comprising a predicted Doppler frequency shift, a predicted GNSS code phase offset, a GNSS data bit time prediction, and a GNSS clock time estimate for use by the GNSS receiver for acquiring said GNSS signal.

20. The method as recited in claim **19** further comprising:

using said predicted Doppler frequency shift, said predicted GNSS code phase offset, said GNSS data bit time prediction, and said GNSS clock time estimate for:

tuning to a carrier frequency;

decreasing a time for making said measurement of said Doppler frequency shift;

narrowing a range of GNSS code phase offsets for making a GNSS code phase offset determination; and

generating a GNSS clock time tag for said GNSS signal.

21. The method as recited in claim **17** further comprising:

receiving at least one GNSS code phase offset determination for said GNSS signal received at said mobile electronic device; and

determining by said speed determiner said geographic position of said mobile electronic device based at least in part on said GNSS code phase offset determination.

22. The method as recited in claim **17** further comprising receiving an offline wireless signal having said speed; and wherein:

using a speed comparator to determine when said speed exceeds said speed threshold.

23. The method as recited in claim **17** wherein using said speed determiner further comprises:

using a relative measurement calculator to calculate a plurality of measured range rates corresponding to a plurality of said GNSS Doppler frequency shift measurements and to calculate a plurality of expected range rates between said mobile electronic device and a plurality of GNSS satellites; and

comparing said relative measured range rates with said expected range rates to determine said speed.

24. The method as recited in claim **17** further comprising:

initiating an action in response to said control signal and wherein said action is selected from the group consisting of: generating an audible notification by said mobile electronic device when a user input device in said mobile electronic device is operated, restricting an operation of a user input device of said mobile electronic device, requiring the use of a hands-free operation device to operate said mobile electronic device, and requiring the use of a voice activation system to operate said mobile electronic device.

25. The method as recited in claim **17** further comprising:

receiving one or more offline wireless signals comprising a predicted Doppler frequency shift, a predicted GNSS code phase offset, a GNSS data bit time prediction, and a GNSS clock time estimate;

using said predicted Doppler frequency shift, said predicted GNSS code phase offset, said GNSS data bit time prediction, and said GNSS clock time estimate for:

tuning to a carrier frequency;

decreasing a time for making said measurement of said Doppler frequency shift;

narrowing a range of GNSS code phase offsets for making a GNSS code phase offset determination; and

generating a GNSS clock time tag for said GNSS signal;

transmitting to a station an offline GNSS data signal comprising said GNSS Doppler frequency shift measurement, said GNSS code phase offset determination, and a time tag;

determining by said station said geographic position of said mobile electronic device based at least in part on said GNSS code phase offset determination;

using a speed determiner configured to use an orbital parameter for a GNSS satellite to determine an expected value proportional to an expected range rate between said mobile electronic device and said GNSS satellite;

using said expected value with said GNSS Doppler frequency shift measurement to determine said speed and to generate said control signal in response to determining that said speed of said mobile electronic device exceeds said speed threshold; and

receiving from said station an offline signal which conveys said control signal when said station uses said GNSS Doppler frequency shift measurement to determine that said speed of said mobile electronic device exceeds said speed threshold.

26. The method as recited in claim **25** wherein using said speed determiner further comprises:

using a relative measurement calculator to calculate a plurality of measured range rates corresponding to a plurality of said GNSS Doppler frequency shift measurements and calculating a plurality of expected range rates between said mobile electronic device and a plurality of GNSS satellites; and

comparing said relative measured range rates with said expected range rates to determine said speed.

27. The method as recited in claim **17** further comprising:

using said control signal to convey said speed from a base station to said mobile electronic device; and

using said control component to control an operation of said mobile electronic device in response to said control signal.

28. The method as recited in claim **17** further comprising:

utilizing a speed determiner to use said GNSS Doppler frequency shift measurement to determine that a speed of said mobile electronic device exceeds said speed threshold; and

generating said control signal in response to said determining.

29. The method as recited in claim **28** further comprising:

receiving one or more offline wireless signals comprising a predicted Doppler frequency shift, a predicted GNSS code phase offset, a GNSS data bit time prediction, and a GNSS clock time estimate.

30. The method as recited in claim **28** further comprising:

using said predicted Doppler frequency shift, said predicted GNSS code phase offset, said GNSS data bit time prediction, and said GNSS clock time estimate for:

tuning to a carrier frequency;

decreasing a time for making said measurement of said Doppler frequency shift;

narrowing a range of GNSS code phase offsets for making a GNSS code phase offset determination; and

generating a GNSS clock time tag for said GNSS signal.

31. The method as recited in claim **28** further comprising:

using a geographical position corresponding to said mobile electronic device and an orbital parameter for a GNSS satellite to determine an expected value proportional to an expected range rate for said GNSS satellite; and

using said expected value with said GNSS Doppler frequency shift measurement to determine said speed.

32. The method as recited in claim **31** further comprising:

using a relative measurement calculator to calculate a plurality of measured range rates corresponding to a plurality of said GNSS Doppler frequency shift measurements and to calculating a plurality of expected range rates between said mobile electronic device and a plurality of GNSS satellites; and

comparing said measured range rates with said expected range rates to determine said speed.

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